



DRAFT FINAL

Route 1 Multimodal Improvements Study

Existing Conditions Summary

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Existing Conditions Summary

1. Introduction

1.1. PROJECT BACKGROUND

US Route 1/Richmond Highway (hereon referred to as Route 1) is a major north-south primary arterial roadway linking Washington DC, Arlington County, the City of Alexandria, and southern suburbs including Fairfax County and Prince William County. Within Arlington County, Route 1 serves a variety of travelers, including those who use the road as a regional highway to access Washington DC to the north, the City of Alexandria and Fairfax County to the south and those who use the road for access to destinations in Crystal City and Pentagon City including Ronald Reagan Washington National Airport. Route 1 carries more than 45,000 vehicles per day in the Crystal City area.

For the past 10 years, the evolution of Crystal City into a more multimodal area has been guided by Arlington County's Crystal City Sector Plan and its accompanying Crystal City Multimodal Transportation Study. Route 1 is a key component of the sector plan and the study. The long-term objective for Route 1 is to convert the highway portion of this road to an urban boulevard. Such a conversion would result in wide sidewalks, landscaped buffers with street trees, and an appropriate number of travel lanes to serve vehicles and transit. Converting Route 1 to an urban boulevard also would provide the opportunity for adjacent buildings to activate the Route 1 frontage.

As a result of the integrated land use and transportation planning, Crystal City and Pentagon City have attracted major new development projects, especially the establishment of Amazon's second headquarters (HQ2), which will bring 25,000 jobs or more to these areas, and which is leading many other landowners to redevelop their properties. The November 2018 memorandum of understanding between Amazon and the Commonwealth of Virginia includes a commitment by the Commonwealth "to expeditiously evaluate and implement opportunities to

improve safety, accessibility, and the pedestrian experience crossing Route 1." With this commitment, the Virginia Department of Transportation (VDOT) is taking the lead to develop and analyze potential improvement options.



Route 1 at 20th Street S.



Route 1 at 23rd Street S

With the Commonwealth's commitment to improve Route 1—supported by the planning efforts of Arlington County and the National Landing BID —VDOT is moving forward with the necessary transportation analysis and engineering study to make the best decision possible on a future Route 1 in Crystal City. In coordination with Arlington County, this study of Route 1, from approximately 12th Street S to 23rd Street S, will explore an at-grade urban boulevard, but also review and compare potential improvements to the current elevated condition, and the elevated urban boulevard described in the Crystal City Sector Plan.

1.2. STUDY PURPOSE

The purpose of the project is to improve multimodal connectivity and accommodations along and across Route 1 in Crystal City to meet the changing transportation needs of this growing urban activity center. The creation of an additional Amazon US Headquarters (HQ2) and other on-going development in the Crystal City/Pentagon City area is expected to increase multimodal transportation demand in an already heavily developed area with limited space for expanding the footprint of the transportation network. With increasing commercial and residential densities, there is a need to increase safety for all users including pedestrians, bicyclists, transit riders, and motorists, while also improving multimodal accessibility throughout Crystal City/Pentagon City, particularly to transit stations. Increased multimodal accessibility will improve person throughput for the corridor, which should also improve the pedestrian and bicycle experience crossing Route 1.

To achieve the safety and multimodal connectivity, this study will build upon this analysis of existing conditions and review and analyze various alignments and configurations to convert



Route to an urban boulevard between 23rd Street S and 12th Street S. Ultimately, the study aims to provide sufficient information toward a future project on Route 1 in Crystal City.

1.3. STUDY METHODOLOGY AND ASSUMPTIONS

The procedures and assumptions for this Route 1 Multimodal Improvements study follow the agreed-upon traffic analysis methodology and design criteria documented in the project Framework Document (**Appendix A**). This project utilizes existing available data sources to facilitate the transportation analyses across all modes within the Route 1 corridor – pedestrians, bicycles, transit, and vehicles.

Separate from this project, Arlington County is conducting a comprehensive Pentagon City Planning Study to evaluate future land use scenarios in the area and pivoting from the County's 1976 Phased Development Site Plan (PDSP). The County's study will result in a draft Pentagon City PDSP Update Planning Study Plan, which will be vetted with the public and is expected to convey new land use policies, redevelopment principles, and supporting urban design guidelines for future growth within Pentagon City. As part of this County's study, Arlington County has developed and calibrated traffic analysis models that encompass nearly the entire Route 1 study area and contain existing peak period traffic volumes and signal timings. For the VDOT Route 1 Multimodal Improvements study, Kimley-Horn is making use of these existing models and previously collected traffic data to ensure consistency between the VDOT's and Arlington County's studies, as well as overcome challenges in data collection during the ongoing COVID-19 pandemic.

1.4. TRANSPORTATION ANALYSIS STUDY AREA

The multimodal transportation analysis study project study area, as shown in **Figure 1-1**, includes Route 1 between the I-395/Route 110 interchange and the Washington National Airport Access Road (Route 233) interchange, inclusive of the interchanges and intersections along this segment of Route 1. The analysis study area also includes the parallel north-south Arlington County streets of S Fern Street, S Eads Street, S Clark Street, S Bell Street, and Crystal Drive, as well as the overlapping east-west Arlington County streets of 12th Street S, 15th Street S, 18th Street S, 20th Street S, and 23rd Street S. The signalized and unsignalized intersections and the interchanges along these streets are included in the study area, as well as associated sidewalks and bicycle facilities.



Route 1 over 18th Street S

Referring to **Figure 1-1**, there are three study area sub-designations along Route 1:

- **Core Street Study Area:** This is the concentrated area in which the street network reconfiguration alternatives and concept design will be focused. This area will have the most detailed multimodal analysis (shown in **dark blue**).
- **Vissim Operational Analysis Area:** this is the area in which Vissim operational (traffic) analysis will be conducted (shown in **light blue**)
- **Synchro Operational Analysis Area:** this is the area in which Synchro operational (traffic) analysis will be conducted (shown in **orange**)

For analysis purposes, the following interchanges are included in the project study area:

- Route 1/I-395/Route 110 – note that only the following south-facing ramps are included:
 - Southbound I-395 to southbound Route 1
 - Northbound Route 1 to northbound I-395
 - Southbound Route 110 to northbound I-395
 - Southbound Route 110 to southbound Route 1
 - Northbound Route 1 to northbound Route 110
- Route 1/15th Street S
- Route 1/Route 233 (Airport Access Road), including the ramp from westbound Route 233 to northbound Crystal Drive

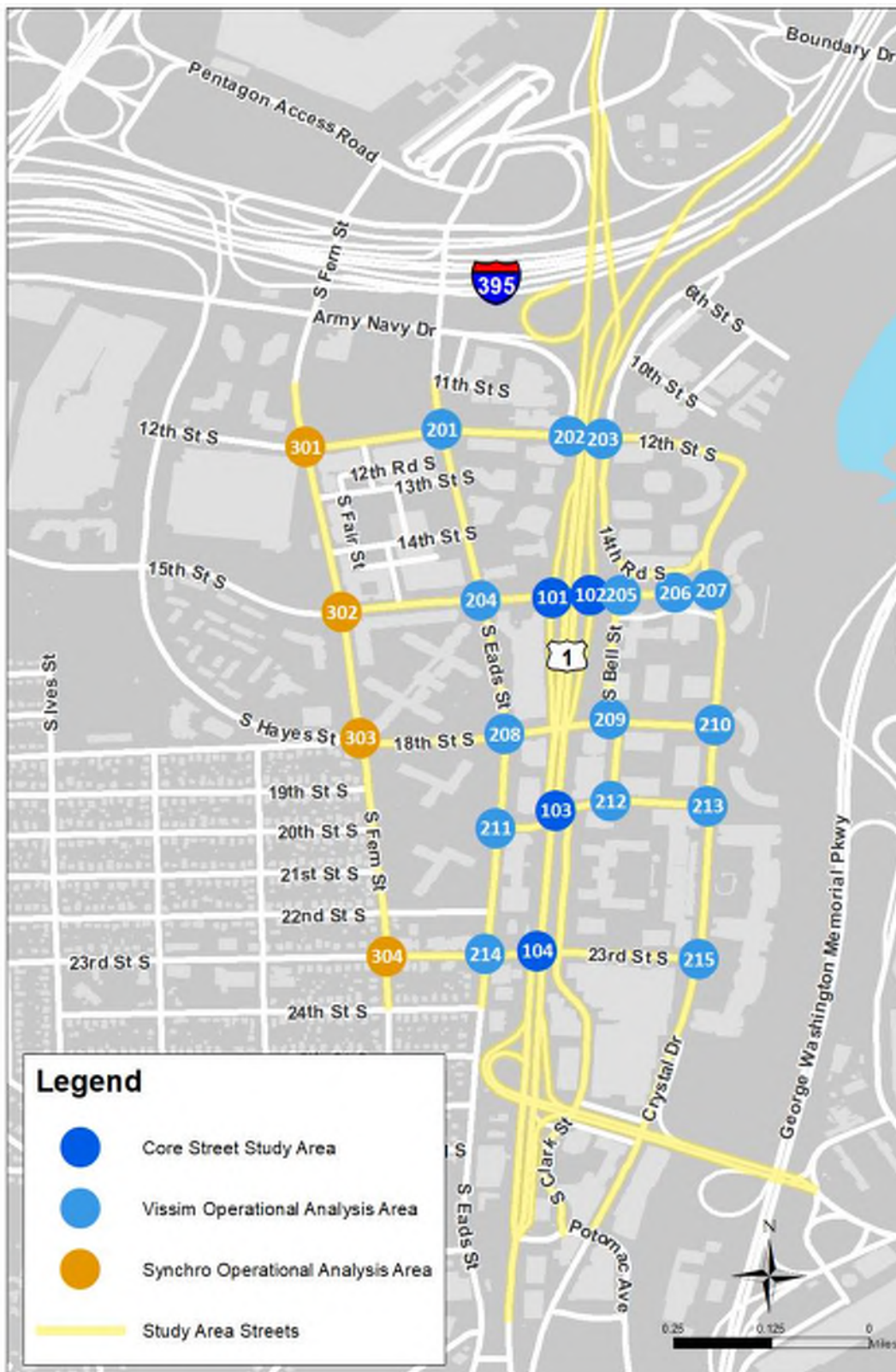


Figure 1-1: Multimodal Transportation Analysis Study Area



The following critical intersections are included in the project study area. **Figure 1-2** illustrates the lane configuration of each intersection:

- 12th Street S/S Fern Street
- 12th Street S/S Eads Street
- 12th Street S/Army Navy Drive
- 12th Street S/Long Bridge Drive/S Clark Street
- 15th Street S/S Fern Street
- 15th Street S/S Eads Street
- Southbound Route 1 ramps/15th Street S
- Northbound Route 1 ramps/15th Street S
- 15th Street S/S Bell Street
- 15th Street S/14th Road S (S Clark Street)
- 15th Street S/Crystal Drive
- 18th Street S/S Fern Street
- 18th Street S/S Eads Street
- 18th Street S/S Bell Street
- 18th Street S/Crystal Drive
- 20th Street S/S Eads Street
- Route 1 and 20th Street S/S Clark Street
- 20th Street S/S Bell Street
- 20th Street S/Crystal Drive
- 23rd Street S/S Fern Street
- 23rd Street S/S Eads Street
- Route 1 and 23rd Street S/S Clark Street
- 23rd Street S/Crystal Drive



Route 1 looking southeast

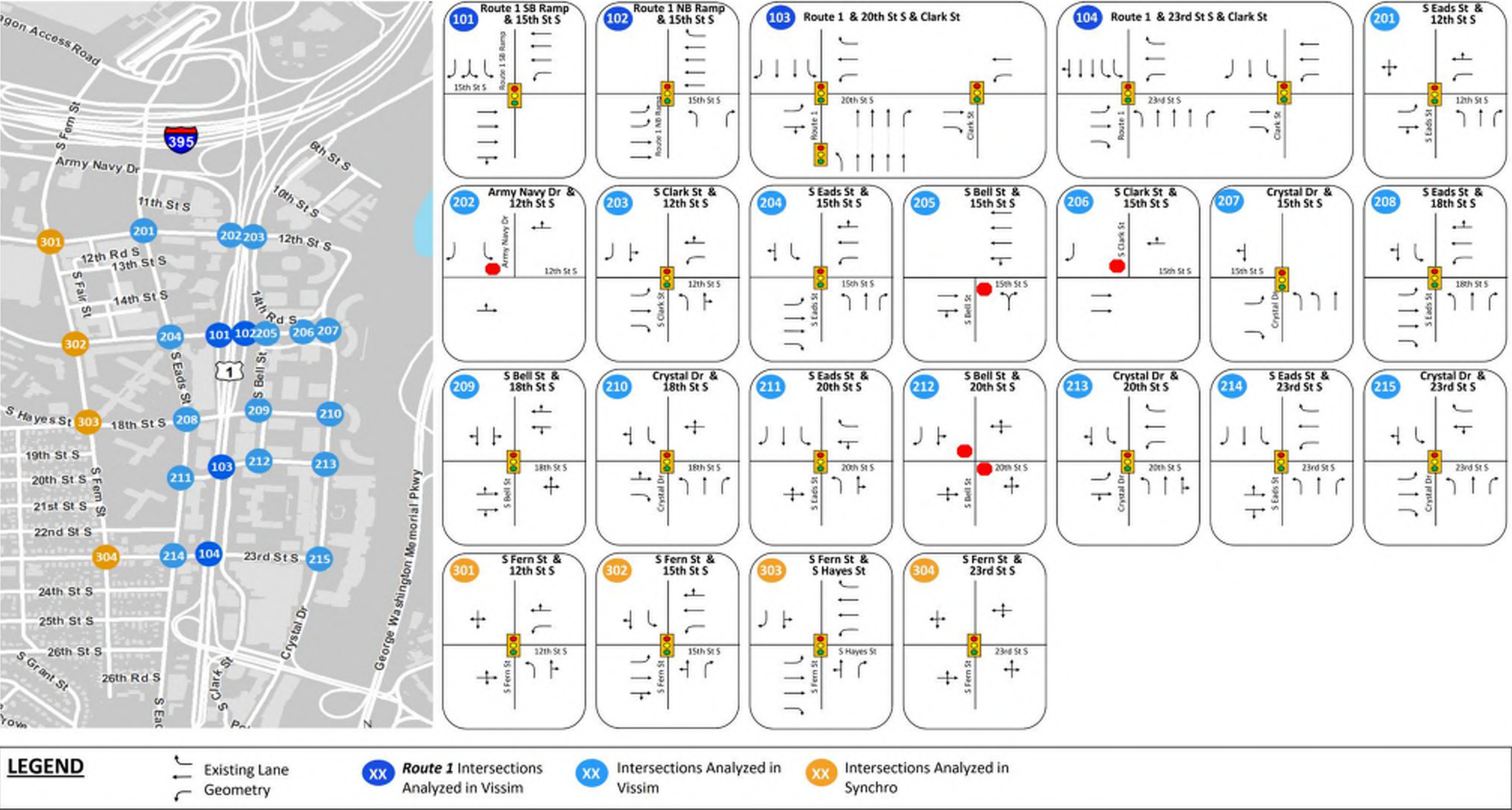


Figure 1-2: Existing Intersection Lane Configurations within Analysis Study Area



2. Existing Conditions

2.1. DATA COLLECTION

This Route 1 Multimodal Improvements study makes use of existing available data sources, especially from Arlington County, to facilitate the multimodal transportation analysis. The traffic models and volume data were provided by Arlington County from their ongoing Pentagon City Planning Study. Kimley-Horn modified the traffic models provided by the County to fit the limits of the study area for the Route 1 multimodal analysis.

In addition, VDOT provided copies of previous studies and analyses and related project documentation such as development plans, crash data, utility information, right-of-way information, and a recent location survey. A list of the data and documents collected and reviewed for this Route 1 study is included in the **Data Collection Summary (Appendix B)**.

2.2. EXISTING ROADWAY INFRASTRUCTURE

For the purposes of this Route 1 Multimodal Improvements project, the project area for the analysis of the existing roadway (and bridge and other) infrastructure is shown in **Figure 2-1**. It should be noted that this “infrastructure analysis project area” includes the segment of Route 1 from north of 23rd Street S to south of 12th Street S, as well as segments of 20th, 18th, and 15th Streets S that are influenced by their interfaces with Route 1.

Referring to **Figure 2-1** and the photos within this section of the report, the existing Route 1 corridor is characterized by a geometry that focuses on vehicle movement, with this segment exhibiting a straight (tangent) alignment and a relatively smooth profile and with a posted 35 mph speed limit. Kimley-Horn evaluated existing geometric conditions in this Route 1 corridor using the survey data provided by VDOT. The evaluation found both the horizontal and vertical geometry to be adequate, with no discernable horizontal curves and with vertical grades less than 3 percent. The evaluation of the vertical profile also confirmed adequate stopping sight distance.



Route 1 looking north from 23rd Street S



Figure 2-1: Route 1 Corridor – Infrastructure Analysis Project Area



2.2.1. Existing Cross Sections

The following existing cross sections were developed to understand how Route 1 and the side streets are currently making use of the space between existing buildings and other constraining features. Representative sample sections were developed between each of the crossing streets along Route 1 from 23rd Street S to 12th Street S. Side street sections were taken at 20th Street S, 18th Street S, and 15th Street S.

Existing Route 1 – Between 23rd Street S and 20th Street S

Figure 2-2 shows the cross section between 23rd Street S and 20th Street S. Notable features of this segment of Route 1 include:

- S Clark Street runs parallel to Route 1 and is very close to Route 1, separated only by a 30-ft wide sidewalk.
- Southbound lanes include dual left turn lanes at 23rd Street S.
- Wide sidewalks and roadway lighting exist on both sides of Route 1.
- Transit stops are located on S Clark Street.
- Building entrances generally front onto the corridor in this segment of Route 1.

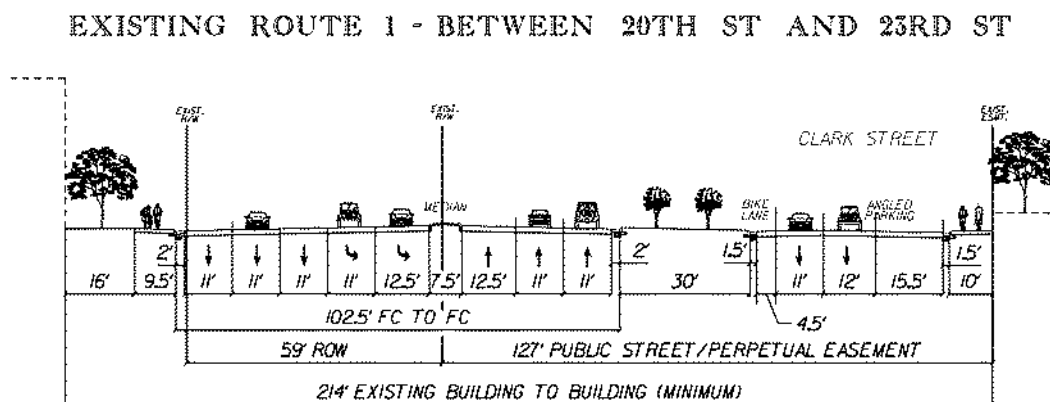


Figure 2-2: Existing Route 1 Cross Section Between 23rd Street S and 20th Street S Cross Section (looking north)



Route 1 and S. Clark St. looking north

**Existing Route 1 – Between 20th Street S and 18th Street S**

Figure 2-3 shows the cross-section between 20th Street S and 18th Street S. Features of this section include:

- Cross section is physically constrained due to existing buildings.
- S Bell Street runs parallel to Route 1, on the east, with buildings in between.
- There is no access to existing building entrances along Route 1; however, several buildings have doors that exit onto the Route 1 sides of their buildings.
- Roadway lighting exists in the median, and a sidewalk and pedestrian lighting are present on the west side.

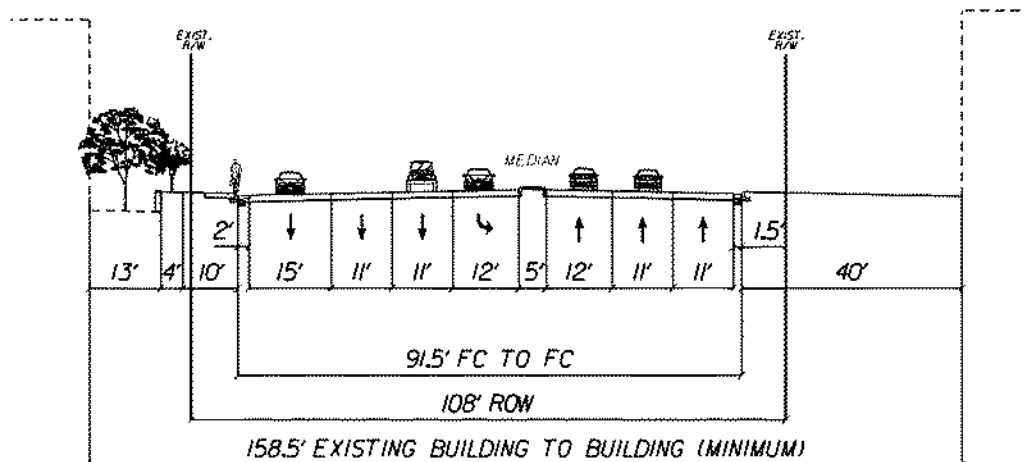
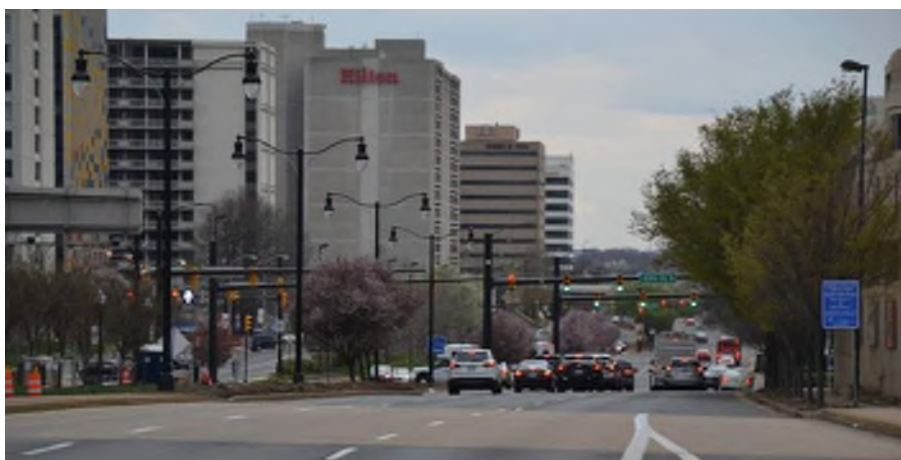
EXISTING ROUTE 1 - BETWEEN 20TH ST AND 18TH ST

Figure 2-3: Existing Route 1 – Between 20th Street S and 18th Street S Cross Section (looking north)



Route 1 over 18th Street S looking south to 20th Street S



Existing Route 1 – Between 18th Street S and 15th Street S

Figure 2-4 shows the cross-section between 18th Street S and 15th Street S. Features of this section include:

- Route 1 is elevated above adjacent land uses in this segment.
- Crystal City Metro Station entrance constrains the cross section near 18th Street S.
- The recent removal of the S. Clark Street overpass by Arlington County on the east side provides additional space for future street elements and/or redevelopment.
- S Bell Street runs parallel to Route 1, to the east, at a distance that may allow future redevelopment.
- Interchange ramps to/from 15th Street S occupy space within the cross section.
- There is no access to existing building entrances along Route 1; however, several buildings have doors that exit onto the Route 1 sides of their buildings.
- Roadway lighting existing on both sides of Route 1, and pedestrian lighting exists on the west (southbound) side.
- A sidewalk exists on the west side, proceeding along the ramp from 15th Street S (below) to 18th Street S (at grade with Route 1); stairs exist to/from building exit doors along this sidewalk.

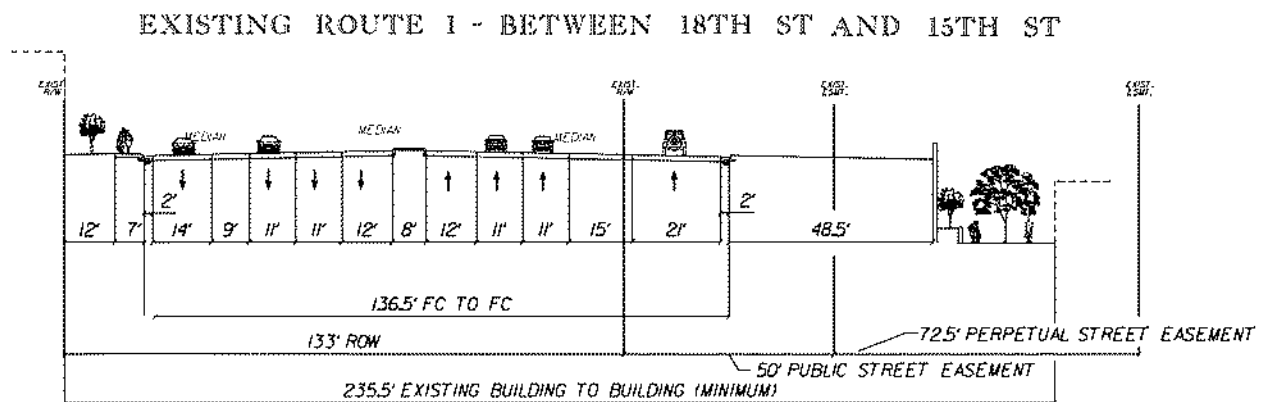


Figure 2-4: Existing Route 1 – Between 18th Street S and 15th Street S Cross Section (looking north)



Route 1 over 18th Street S looking north to 15th Street S

**Existing Route 1 – Between 15th Street S and 12th Street S**

Figure 2-5 shows the cross-section between 15th Street S and 12th Street S. Features of this section include:

- Route 1 is elevated above adjacent land uses in this segment; of note is the former front entrance of the Americana Motel made inaccessible by the retaining wall of the elevated Route 1.
- S Clark Street runs parallel to Route 1 to the east.
- There is no access to existing building entrances along the west side of Route 1; there are building entrances along the east side of S. Clark Street.
- Roadway lighting exists on both sides of Route 1.

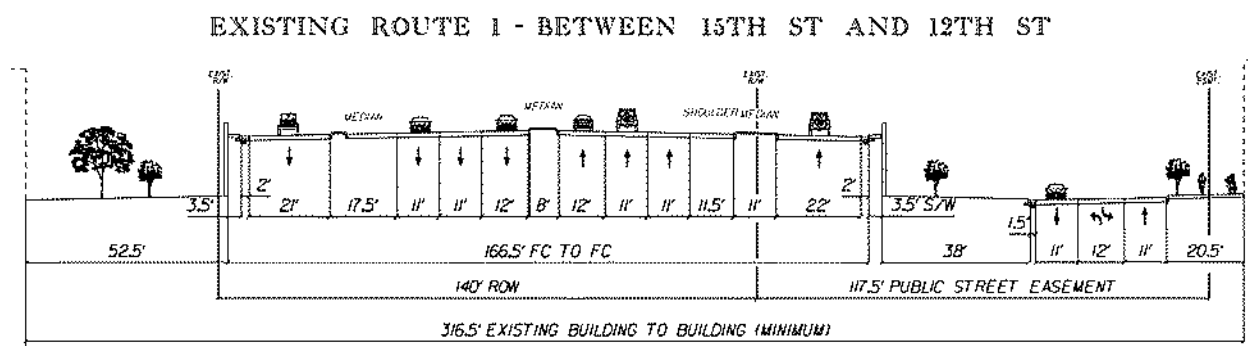


Figure 2-5: Existing Route 1 – Between 15th Street S and 12th Street S Cross Section (looking north)



Route 1 over 12th Street S looking south to 15th Street S
(Note: Americana Motel at right)



Existing 20th Street S

Figure 2-6 shows the cross section along 20th Street S, just west of Route 1. Features of this section include:

- Section is located between two closely spaced signals at Route 1/20th Street S and S Eads Street/20th Street S.
- Sidewalks and roadway lighting exist on both sides of 20th Street, with pedestrian lighting on the right (north) side

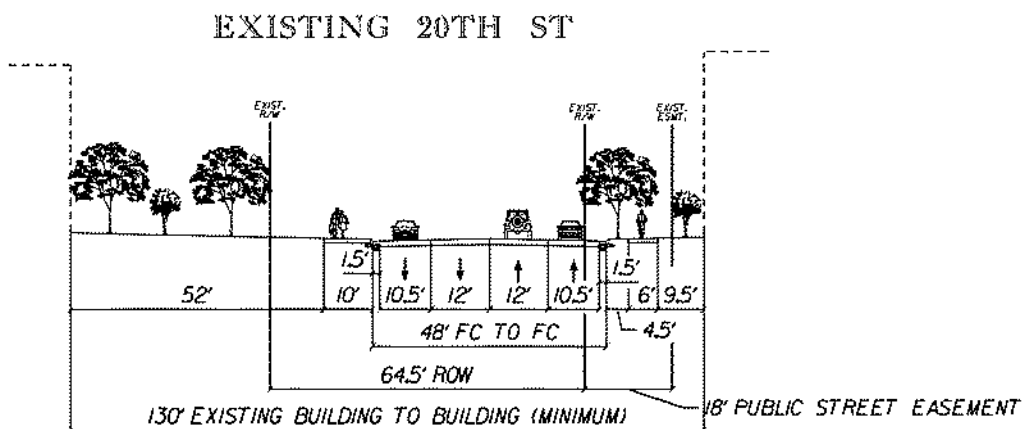


Figure 2-6: Existing 20th Street S Cross Section (looking east toward Route 1)



Route 1 at 20th Street S





Existing 18th Street S

Figure 2-7 shows the cross section along 18th Street S, just west of Route 1. Features of this section include:

- 18th Street S crosses under existing Route 1.
- There are existing bus stops (with saw tooth curbs) located along 18th Street, below Route 1.
- Roadway and pedestrian lighting exist on both sides of 18th Street S.
- There are striped and painted (solid green) bike lanes in each direction.
- Sidewalks greater than 6 feet wide exist on both sides of 18th Street S.

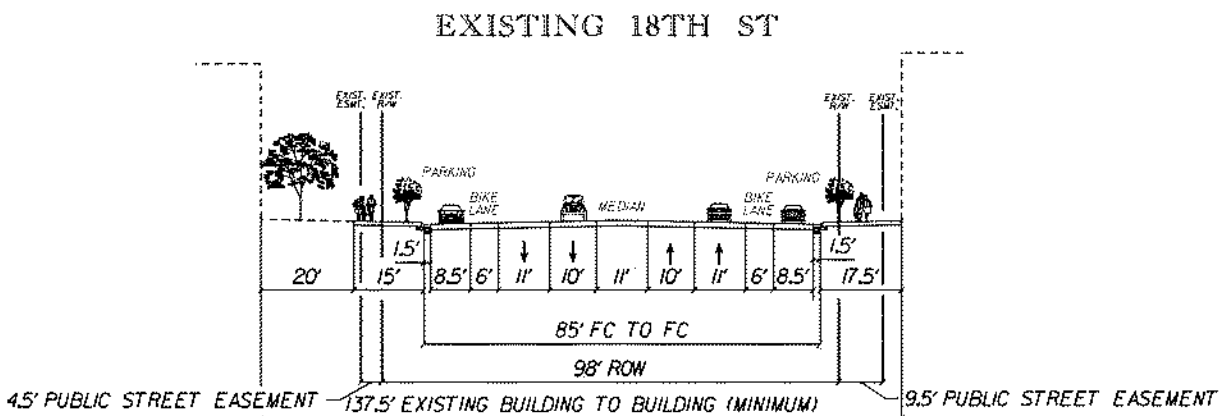


Figure 2-7: Existing 18th Street S Cross Section (looking east toward Route 1)



18th Street S looking west from Route 1 bridge to S Eads St. intersection



Existing 15th Street S

Figure 2-8 shows the cross section along 15th Street S, just west of Route 1. Features of this section include:

- 15th Street S crosses under existing Route 1.
- There is an existing buffered bike lane on the south (eastbound) side.
- Roadway lighting exists on both sides of 15th Street S.
- Sidewalks greater than 6 feet wide exist on both sides of 15th Street S, with marked pedestrian crossings at each of the ramps to/from Route 1.

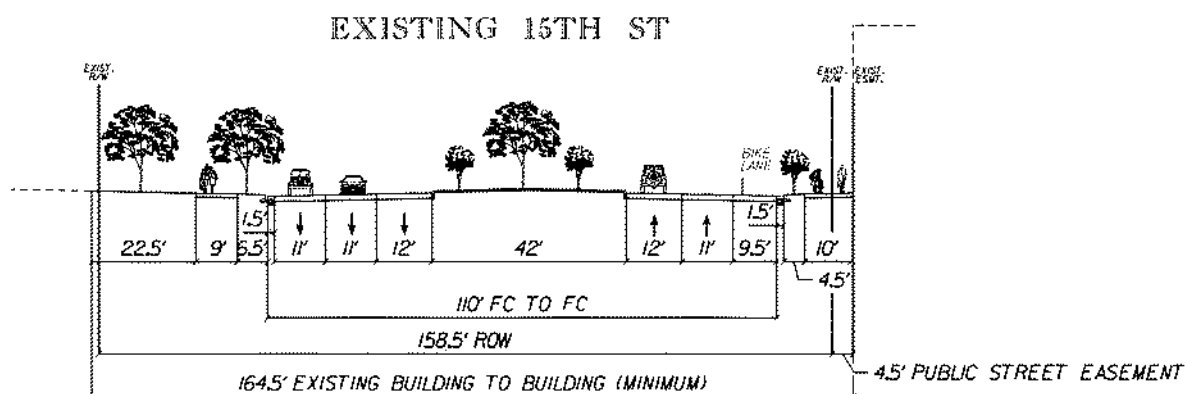


Figure 2-8: Existing 15th Street S Cross Section (looking east toward Route 1)



15th Street S looking east toward Route 1 bridge



2.2.2. Existing Bridges and Retaining Walls

Existing structures along the Route 1 corridor were evaluated based on information in the bridge inspection reports provided by VDOT and observed in the field. The 18th Street S, 15th Street S, and 12th Street S bridges and retaining walls were determined to range from fair to good condition. **Table 2-1** summarizes the findings that are further detailed in **Appendix F – Existing Conditions Memo – Structures**.

Table 2-1: Summary of Existing Structures along Route 1

Summary of Existing Structures			
Structure	Deck Rating	Superstructure Rating	Substructure Rating
Route 1 over 18th Street S	6	7	6
Route 1 over 15th Street S	6	7	6
Route 1 over 12th Street S	7	6	5

Notes:

1. A rating of 5 indicates Fair Condition; 6 indicates Satisfactory Condition; 7 indicates Good Condition.
2. Associated wingwalls and retaining walls for each bridge are in generally good condition.



Existing Route 1 bridge over 18th Street S



2.2.3. Existing Geotechnical Conditions

The existing geotechnical conditions data was collected and reviewed to understand the expected subsurface conditions at the existing structures, pavements, and embankment slopes along Route 1 from 23rd Street S to 12th Street S. The review noted the challenge of construction at the 18th Street S bridge due to the existing building foundations located adjacent to the structure and retaining walls. The review also noted the anticipated unsuitable soils near 12th Street S and 15th Street S that will need to be removed or mitigated, as well as the presence of subsurface water. Additional information and discussion are included in **Appendix G – Existing Conditions Memo – Geotechnical**.

2.2.4. Existing Drainage and Stormwater Management

Existing drainage and stormwater management facilities in the Route 1 corridor were reviewed based on the existing conditions survey data provided by VDOT. The Route 1 Multimodal Improvements project is located within the Roaches Run watershed, also known as the Potomac River – Pimmit Run watershed (HUC 020700100103). There are four primary manmade outfalls identified along the project corridor. All four outfalls eventually flow into the Potomac River. The outfalls are as follows:

- 8'x8' box culvert, crossing Route 1 between 15th Street S and 12th Street S
- 24" pipe, draining east down 15th Street S
- 36" pipe, draining east down the northside of 23rd Street S
- 36" pipe, draining east down the southside of 23rd Street S

There were no existing stormwater management facilities identified in the existing conditions survey treating runoff from the public right-of-way. The street infrastructure in the area was mostly constructed in the 1980's before the current stormwater management regulations were in place. Existing stormwater management facilities located on private property were not included in the survey provided, and these SWM facilities may not exist depending on the date of the development.

2.2.5. Existing Utilities

The Route 1 right-of-way contains the full range of utilities as expected in an urban area. The existing conditions survey identified natural gas, water, sanitary sewer, storm sewer, electric duct banks, and communications duct banks, all located underground. The existing traffic control and streetlight utility lines were not identified in the underground survey. The existing utilities are concentrated on the east side of the Route 1 corridor and mostly remain outside of the existing Route 1 roadway pavement. There appears to be an abandoned 6-inch gas line located on the west side of Route 1.



Water line and fire hydrant

The side streets of 20th, 18th, and 15th Streets S also appear to have a concentration within their rights-of-way. Based on the age and history of the corridor, it should be assumed that abandoned or unidentified utilities may be discovered through additional utility surveys or during construction.



2.3. EXISTING MULTIMODAL TRAFFIC CONDITIONS

This section summarizes the existing conditions operations across all modes of traffic in the study area – pedestrians, bicycles, transit, and vehicles. Many of the measures of effectiveness for each mode are derived from a Vissim microsimulation model of the study area, which allows for complex modeling of interactions among all modes.

2.3.1. Existing Vehicular Traffic Volumes and Travel Patterns

The existing traffic volumes in the Route 1 study area were provided from the Pentagon City Planning Study effort being conducted by Arlington County. County staff provided this data in September 2020. The previously collected 2019 traffic data from the planning study was used to overcome the challenges in data collection during the COVID-19 pandemic and to ensure consistency between the Arlington County study and this VDOT study. Traffic volume data consisted of peak-hour turning movement and freeway mainline/ramp volumes, including heavy vehicle percentages. The only locations in which traffic counts were not available were for the ramps at the I-395/Route 1 interchange; these ramp volumes were derived using VDOT's StreetLight Data account¹ by obtaining estimated peak-hour volume proportions and applying these proportions to the known balanced counts along Route 1 just south of the interchange.

The representative weekday AM and PM peak hour traffic volumes are provided in **Figure 2-9** and **Figure 2-10**, respectively.

¹ StreetLight Data is an online data metrics tool that enables analysis of anonymized transportation data collected from mobile devices using Location-Based Services (LBS).

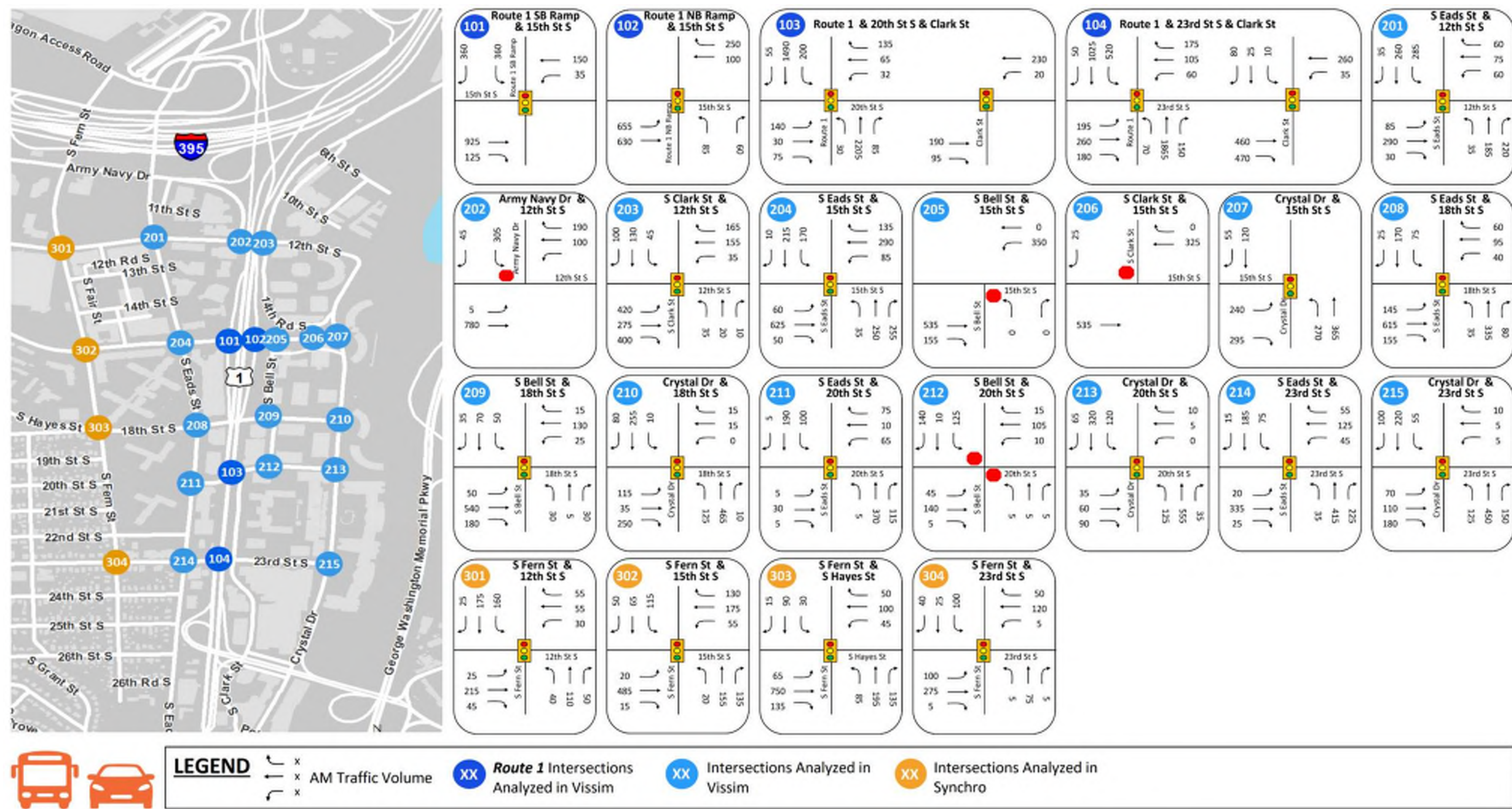


Figure 2-9: Existing AM Peak Hour Vehicle Turning Movement Counts

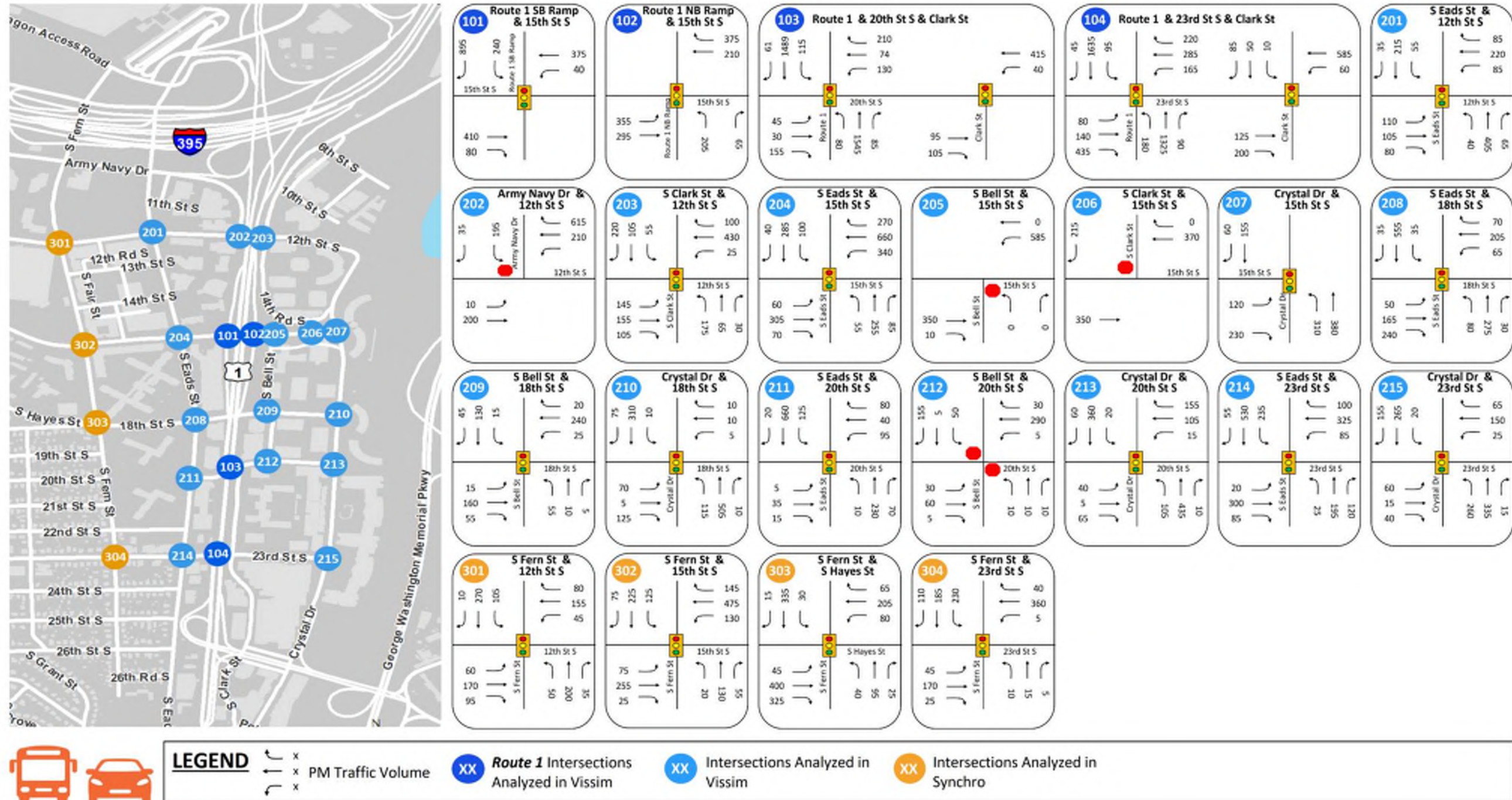


Figure 2-10: Existing PM Peak Hour Vehicle Turning Movement Counts



2.3.2. Existing Vehicular Traffic Operations

Traffic operations analyses were conducted to identify the current performance of the Route 1 corridor and study area intersections under the existing traffic conditions. Vehicular traffic was analyzed using Synchro 10 and Vissim 11 for the study area limits. Vissim also modeled pedestrian, bicycle, and transit within the network to capture the multimodal interaction. The use of these software is consistent with the VDOT *Traffic Operations and Safety Analysis Manual 2.0* (TOSAM). **Figure 1-1** included the extents of the Vissim and Synchro analysis areas.

Synchro Analysis Overview

The Synchro analysis of study area intersections is based on *Highway Capacity Manual* (HCM) methodology to measure intersection capacity based on vehicle delays. Synchro is used to report vehicle delay and level of service (LOS) at study area intersections. LOS is a qualitative measure used an indicator of motorist perceptions within a traffic stream. The HCM defines six thresholds, LOS A through F, with A as the best and F the worst. **Table 2-2** shows the ranges of delay per vehicle for signalized and unsignalized intersections, with corresponding LOS. Arlington County does not maintain a minimum LOS requirement. In most urban areas, LOS D is generally considered acceptable to VDOT, particularly along arterial and collector streets with significant traffic volumes.

Table 2-2: Level of Service and Corresponding Delay Summary

Level of Service	Average Control Delay per Vehicle (seconds)		General Service Description for Signalized Intersections
	Signalized	Unsignalized	
A	≤ 10	≤ 10	Free Flow
B	> 10 – 20	> 10 – 15	Stable Flow (slight delays)
C	> 20 – 35	> 15 – 25	Stable Flow (acceptable delays)
D	> 35 – 55	> 25 – 35	Approaching Unstable Flow (tolerable delays)
E	> 55 – 80	> 35 – 50	Unstable Flow (intolerable delay)
F	> 80	> 50	Forced Flow (congested and queues fail to clear)

Source: *Highway Capacity Manual, 2010 Edition*

Vissim Analysis Overview

Vissim simulates the movements and behavior of individual vehicles and other travelers, as well as the interactions between various travel modes. A Vissim microsimulation model was calibrated to observed traffic conditions in the Route 1 study area. Specifically, the model was calibrated to accurately replicate the existing traffic volumes and flows, multimodal (transit, pedestrian, and bicycle) volumes at intersections in the study area, travel time along key corridors, queuing and congestion at study area intersections, and known traffic bottleneck locations. Driver behaviors and vehicle operating parameters were adjusted to better reflect observed traffic conditions in Route 1. A **Vissim Model Validation and Calibration Summary** is provided in **Appendix C**.



The VDOT TOSAM states that LOS shall not be used to support results from microsimulation (e.g., Vissim) models; therefore, for intersections analyzed using Vissim, *microsimulation delay* will be reported and color-coded in a similar fashion as analogous HCM delay-based LOS thresholds and noted with “HCM-Analogous LOS”. Simulation network representative hours are based on the Pentagon City Planning Study analysis periods in the models provided by Arlington County. A three-hour simulation period was selected to capture the onset and dissipation of study area congestion (seeding, peak period, and shoulder).

Measures of Effectiveness

The following measures of effectiveness (MOEs) were used for the operational analysis of the roadway network under existing conditions.

- Intersection Delay and LOS (Microsimulation Delay and HCM-Analogous LOS)
- Intersection Queues
- Network Performance and Travel Times

A summary of these vehicular MOEs is provided in the following sub-sections. Detailed Synchro and Vissim results are provided in **Appendix D**.

Intersection Performance (Delay, LOS, and Queues)

The existing AM and PM peak hour HCM-analogous Level of Service (LOS) and microsimulation delay for the Vissim Operational Analysis Area are reported in **Figure 2-11** and **Figure 2-12** respectively. See below for a discussion of Core Street Study Area intersections operational issues and other intersections with an analogous LOS less than D. There were no Synchro intersections that resulted in a worse LOS than LOS D.

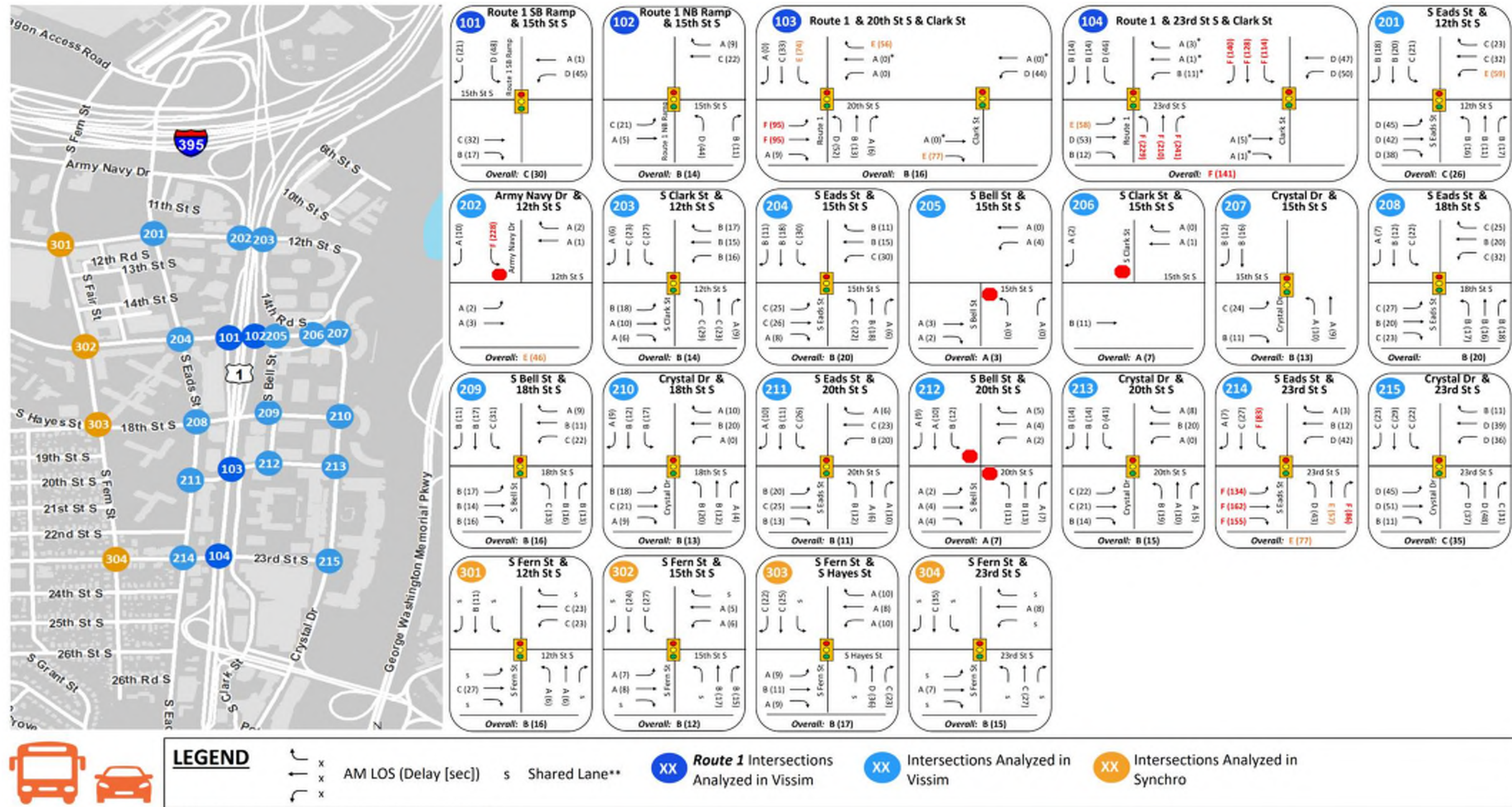


Figure 2-11: Existing AM Peak Hour LOS and Delay

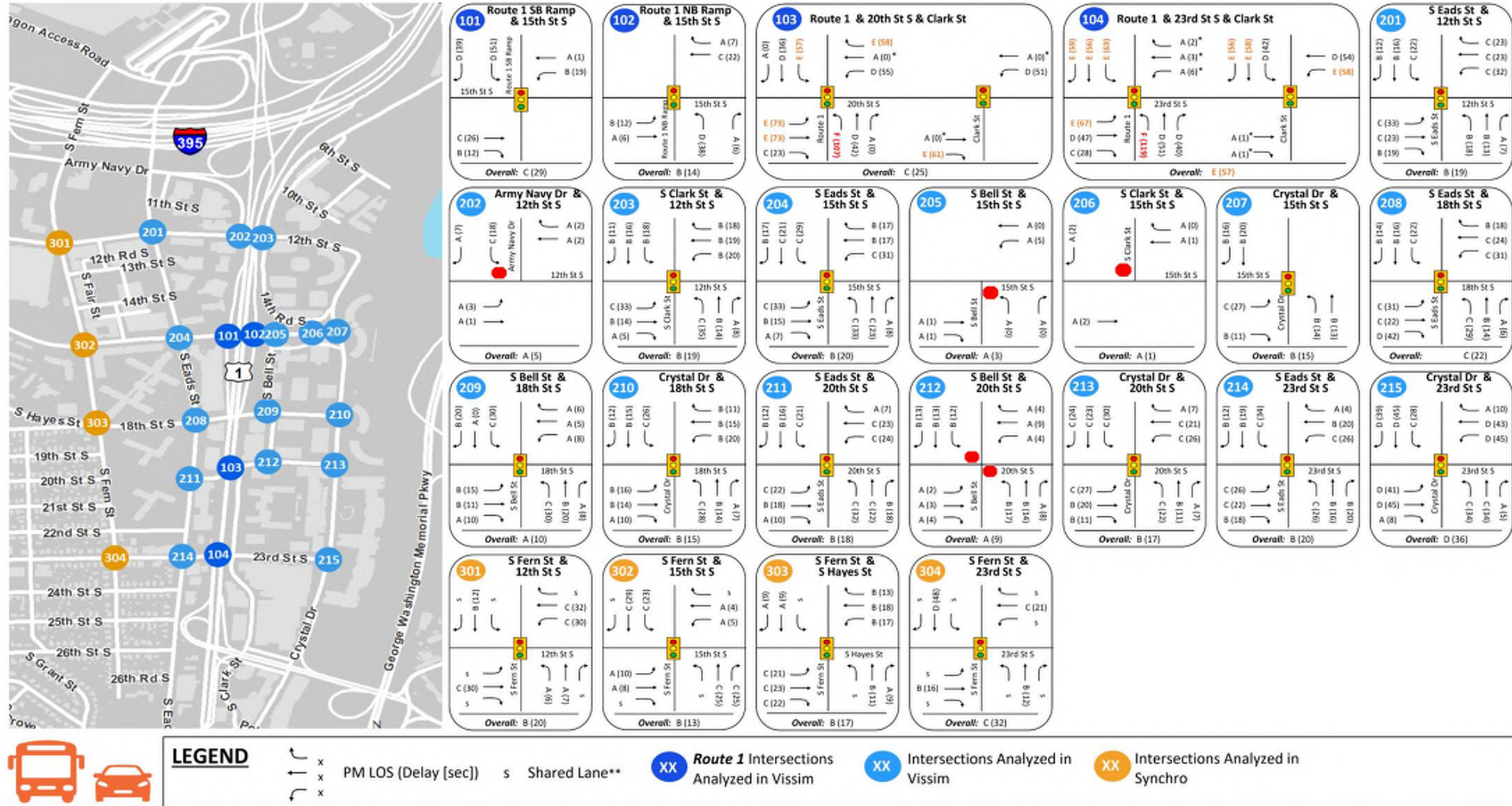


Figure 2-12: Existing PM Peak Hour LOS and Delay

Notable operational issues and observations for the Core Street Study Area identified in the Vissim models, including a discussion of intersections and approaches at LOS D or worse, are discussed below for the AM and PM peak hours, respectively. The complete network intersection microsimulation delay and HCM-analogous LOS summary can be found in **Appendix D**.

Existing AM Peak Hour Operational Issues

Route 1 and 15th Street S (Interchange Ramp Signals)

- Heavy eastbound demand for the left turn onto the northbound Route 1 ramp (more than 650 vph) creates queue spillback along 15th Street S through the intersection with the southbound Route 1 ramps. While the eastbound movement operates at an acceptable LOS at both intersections, maximum queues for the eastbound left turn spill out of the turn bay west of the intersection with the southbound ramps.
- At 15th Street S and the southbound ramps, the southbound off-ramp left turning movement experiences an average delay of approximately 48 seconds per vehicle (LOS D). Vehicles must wait or maneuver around the downstream left-turning queue when turning left onto eastbound 15th Street S.
- Also, at the intersection with the southbound ramps, the permissive westbound left turn must yield to the high eastbound through traffic and thus experiences an average delay of approximately 45 seconds per vehicle (LOS D).
- At the intersection with the northbound ramps, the northbound left-turn from the off-ramp operates at LOS D but sees minimal queueing due to low demand (85 vph).

18th Street S Underpass at Route 1

- The intersections of 18th Street S and S Eads Street and S Bell Street both operate at LOS B. Queues and delays are minimal at both intersections.

Route 1 and 20th Street S/S Clark Street Intersection Cluster

- **This intersection cluster, along with the Route 1 intersection at 23rd Street S, provides access to the adjacent S Clark Street frontage road, and runs split-phased to accommodate turns onto (and, in the case of 23rd Street S, off of) S Clark Street. This means that the eastbound and westbound movements are unable to run at the same time, despite relatively low volumes. These additional signal phases require longer cycle lengths to accommodate all movements. This results in delay and queue spillback for the heaviest-demand movements in both the AM and PM peaks.**
- The southbound Route 1 left turn movement to S Clark Street/20th Street S is observed to extend beyond the available storage length, and the queue is not dissipated in the allotted green time. In addition, the long cycle length causes even greater delay for vehicles remaining in the queue. This situation results in an average southbound left turn delay of approximately 74 seconds per vehicle, with average queue length of 160 feet (approximately the length of the turn bay) and maximum queues in excess of 550 feet.

This movement operates at an analogous level of service of E, and the overall southbound approach operates at LOS D.

- The westbound right turn from 20th Street S onto northbound Route 1 must yield to pedestrians crossing Route 1 and operates at LOS D. The queue is often not fully dissipated within the allotted green time.
- The eastbound left turn from 20th Street S onto northbound Route 1 experiences an average delay of approximately 95 s/veh (LOS F). With a single left turning lane and a short green time, the queue is barely able to empty during the green time. The eastbound left-turn queue does not interfere with the eastbound right-turn movement or the upstream intersection of 20th Street S and S Eads Street.

Route 1 and 23rd Street S/S Eads Street/S Clark Street Intersection Cluster

- **The intersection cluster serves movements along 23rd Street S and S Clark Street resulting in a long cycle length to accommodate the additional signal phases, creating significant delays and queueing for the heaviest-demand movements in both the AM and PM peaks.**
- The average delay for the northbound Route 1 approach, which carries a heavy demand of more than 2,000 vph during the AM peak, is more than 210 s/veh (LOS F). The average queue for the northbound through movements (more than 1,200 feet) prevents left-turning vehicles from accessing the left-turn pocket. The northbound approach congestion is worsened by the merge with the on-ramp from Route 233. The maximum queues for the northbound approach extend nearly 1,700 feet, near the signal with 27th Street S.
- The eastbound and westbound left-turning vehicles at Route 1 must yield to oncoming traffic and pedestrians. The eastbound queue spillback from the through and left turning lanes at the intersection of 23rd Street S and Route 1 causes significant delays and queueing at the upstream intersection of 23rd Street S and S Eads Street. The eastbound queues extend beyond the available storage and block through/left-turning movements. Vehicles travelling eastbound approaching S Eads Street experience an average delay of 170 seconds/vehicle (LOS F), with average queues of nearly 400 feet and maximum queues in excess of 900 feet. Similarly, northbound traffic on S Eads Street approaching 23rd Street S experiences an average delay of approximately 70 seconds/vehicle (LOS E).
- Vehicles travelling southbound on S Clark Street experience an average delay of approximately 130 seconds/vehicle (LOS F). The queue to turn right does not dissipate in the allotted green time. These vehicles must then wait for all the other phases in the intersections before making the right turn.

Existing PM Peak Hour Operational Issues

Route 1 and 15th Street S (Interchange Ramp Signals)

- The southbound off-ramp from Route 1 at the signal with 15th Street S experiences an average queue of approximately 250 feet due to southbound right-turning vehicles, which also impacts some left-turning vehicles due to the shared center lane. The maximum queues for the southbound approach extend back more than 1,100 feet and onto the Route 1 freeway mainline. Even with the lengthy queues, this results in an average delay of approximately 43 s/veh (LOS D) for the southbound approach (39 s/veh for southbound right turns and 51 s/veh for southbound left turns).
- The northbound Route 1 off-ramp left turn at 15th Street S experiences a delay of approximately 38 s/veh (LOS D), but it is adequately served within the available green time and does not experience significant queue spillback.

18th Street S Underpass at Route 1

- At the intersection of 18th Street S and S Eads Street, eastbound right-turning vehicles are yielding to pedestrians for a large portion of the allotted green time resulting in a delay of approximately 42 s/veh (LOS D). The right turning queue spills back into the center through lane and is occasionally not served by the allotted green time.

Route 1 and 20th Street S/S Clark Street Intersection Cluster

- **This intersection cluster, along with the Route 1 intersection at 23rd Street S, provides access to the adjacent S Clark Street frontage road, and runs split-phased to accommodate turns onto (and, in the case of 23rd Street S, off of) S Clark Street. This means that the eastbound and westbound movements are unable to run at the same time, despite relatively low volumes. These additional signal phases require longer cycle lengths to accommodate all movements. This results in delay and queue spillback for the heaviest-demand movements in both the AM and PM peaks.**
- The average queue for the heavy movement of vehicles travelling southbound on Route 1 at 20th Street S (more than 1,750 vph) extends beyond the left-turn pocket and prevents left turning vehicles from being able to enter the turn pocket. The southbound Route 1 approach operates at an overall LOS D.
- The northbound Route 1 left turning queue spills back out of the turn bay and onto the northbound mainline. The average delay for the northbound left turn is approximately 107 s/veh (LOS F). In addition, the green time for the left turning movement is short and only allows approximately three vehicles to be served during a cycle, leaving several queued vehicles each cycle. The northbound through queue extends to the intersection of 23rd Street S and Route 1.
- Eastbound traffic on 20th Street S turning left onto Route 1 experiences an average delay of 73 s/veh (LOS E) given the long cycle length; however, the eastbound queue is served in the allotted green time.

- Similarly, the westbound traffic experience average delays of approximately 60 s/veh (LOS E) due to higher volumes (more than 450 vph on the approach), right turns yielding to pedestrians, and long intervals between green times.

Route 1 and 23rd Street/Eads Street/Clark Street Intersection Cluster (including 23rd Street and Crystal Drive)

- **The intersection cluster serves movements along 23rd Street S and S Clark Street resulting in a long cycle length to accommodate the additional signal phases, creating significant delays and queueing for the heaviest-demand movements in both the AM and PM peaks.**
- The average queue for the heavy movement of vehicles travelling southbound on Route 1 at 23rd Street S (more than 1,750 vph) extends beyond the left-turn pocket and prevents left turning vehicles from being able to enter the turn pocket. The average queue for the southbound approach is approximately 350 feet, with maximum queues of nearly 850 feet. The southbound Route 1 approach operates at an overall LOS E.
- Vehicles traveling eastbound on 23rd Street S and turning left onto Route 1 northbound must yield to oncoming traffic and thus experience delays of approximately 67 s/veh (LOS E). However, unlike the AM peak period, the queue along eastbound 23rd Street S does not spill back to the intersection with S Eads Street.
- Northbound Route 1 left turning vehicles experience an average delay of 119 s/veh (LOS F) due to the northbound through queue on average spilling back and preventing left turning vehicles moving into the left turning pocket. The northbound Route 1 approach operates at an overall LOS E.
- Southbound vehicles on S Clark Street operate at an analogous level of service D. This is due to the increased number of signal phases before the approach receives a green indication. The queue is cleared during the allotted green time.
- At the intersection of 23rd Street S and Crystal Drive (LOS D), southbound vehicles experience a delay of approximately 45 seconds/vehicle. With only one southbound lane approaching the intersection, the queue is not always fully dissipated during each cycle.

Existing Travel Times and Network Travel Speeds

The average travel time for Route 1 between I-395 and Route 233 were collected for the northbound and southbound direction. **Table 2-3** shows the AM and PM peak results. Additional travel time segments along parallel arterial routes are summarized in **Appendix D**.

Table 2-3: Average Travel Time

Route Segments	AM Travel Time	PM Travel Time
	(MM:SS)	(MM:SS)
Route 1 between I-395 and Route 233		
Route 1 Northbound	05:06	03:33
Route 1 Southbound	02:07	03:32

The Route 1 travel time segment is about 4,900 feet long with a 35 mph posted speed limit. For reference, an average travel time without stops would typically be approximately one minute and thirty seconds (1:30). The greatest travel times are observed during the AM peak hour, along the northbound direction due to delay associated with the 23rd Street S traffic signal. For the PM peak hour, however, an approximately equal amount of delay is experienced northbound and southbound, resulting in similar travel times for both directions.

Figure 2-13 provides an illustration of the average vehicular speeds during AM and PM peak that can be used to further understand the travel time trends. In the AM model, there are relatively higher northbound and eastbound traffic volumes as vehicles make their way eastbound through the network to turn onto Route 1 northbound. The reverse trend is observed in the PM model with more traffic traveling southbound on Route 1 and westbound on the network arterials.

The lowest speeds are concentrated along the Route 1/20th Street S/S Clark Street and Route 1/23rd Street S/S Clark Street intersection clusters. The most significant source of queueing and delay in the Core Street Study Area are tied to the complex traffic signal operations at those two intersections clusters. Both of these traffic signals along Route 1 provide access to the adjacent Clark Street, and in doing so must provide additional signal phases for turns onto and off of Clark Street. These additional signal phases require longer cycle lengths to accommodate all movements, most of which cannot proceed simultaneously. These situations results in delay and queue spillback especially for the highest-demand movements.

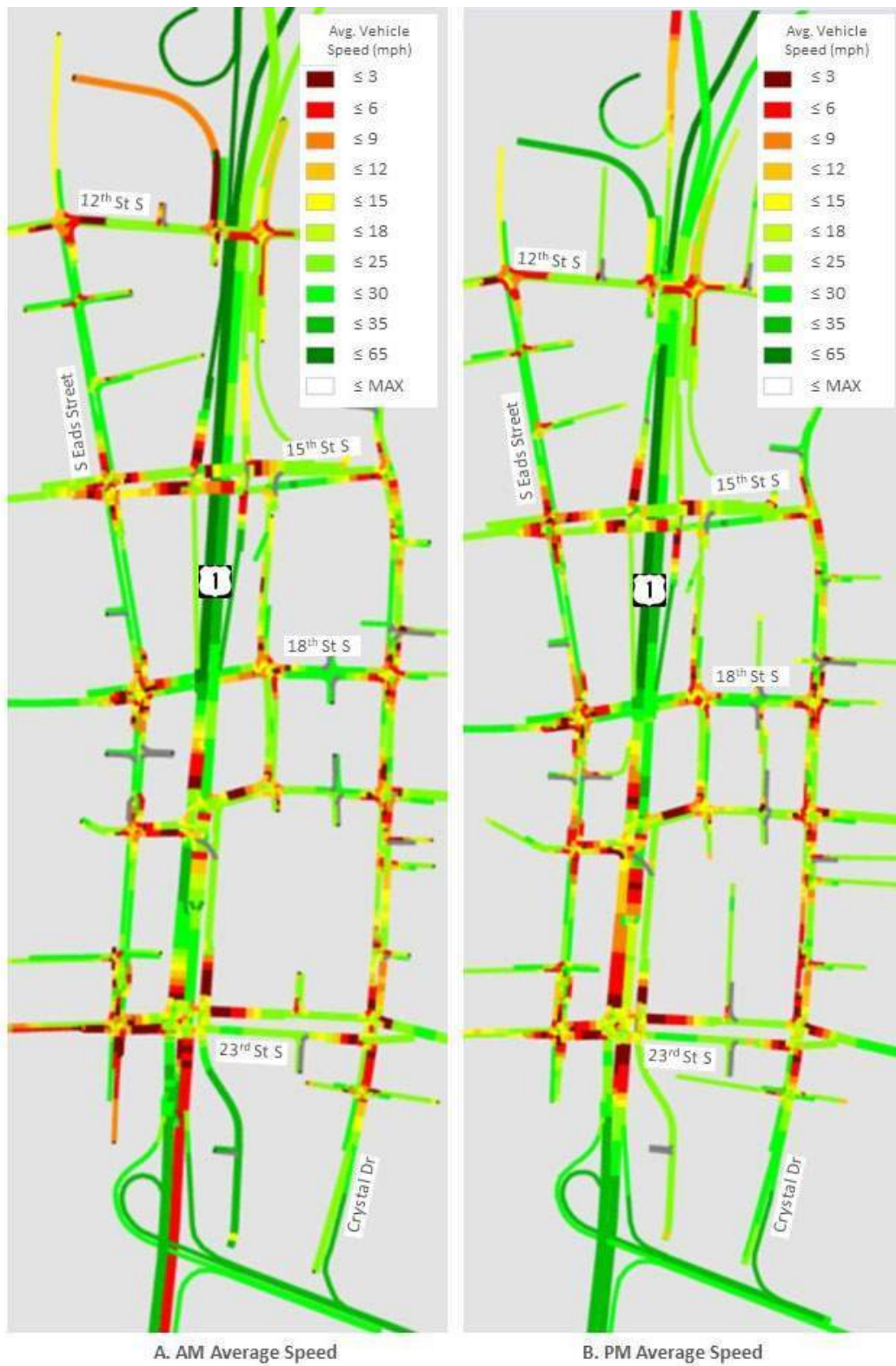


Figure 2-13: Vissim Operational Analysis Area AM and PM Peak Hour Average Speed Maps

2.3.3. Existing Transit Infrastructure and Operations

Transit Infrastructure

The Route 1 transit network includes Metrorail service, local bus service, and commuter bus service and is shown in **Figure 2-14**.

- The Metrorail Blue and Yellow Lines serve the Pentagon City, Crystal City, and Washington National Airport stations via an underground tunnel through the study area, which raises to an elevated platform just north of the airport. Within the study area, the Crystal City Metrorail station is located along 18th Street S and S Bell Street immediately to the east of Route 1. There are two entrances/exits to the station, with escalators available along Bell Street and elevators available along 18th Street. This station features bike racks, bikeshare stations, and bus bays along Bell Street and 18th Street. Along 18th Street S, pedestrian and bicycle accommodations facilitate multimodal access to Metrorail. As of 2017, the Crystal City station averaged more than 10,000 daily weekday boardings.
- Local bus services consist of two agencies: Washington Metropolitan Area Transit Authority (WMATA) Metrobus and Arlington Transit (ART).
- The commuter bus services consist of three agencies: Loudoun County Transit (LCT), Potomac and Rappahannock Transportation Commission (PRTC) OmniRide, and Fairfax County (Fairfax Connector).
- Metroway is an interagency service with WMATA, Arlington County, and City of Alexandria that provides bus rapid transit (BRT) service from between the Pentagon City and Braddock Road Metrorail stations. The Metroway travels on weekday peak period bus-only lanes and stops along 18th Street S and Crystal Drive within the project study area.

Overall, there are 20 bus stops in the study area that accommodate local and commuter routes. Peak headways on these routes range from less than every 10 minutes to once an hour. **Table 2-4** summarizes the different transit routes that serve the Route 1 study area, including frequency and service type.



Bus stops along 18th Street S

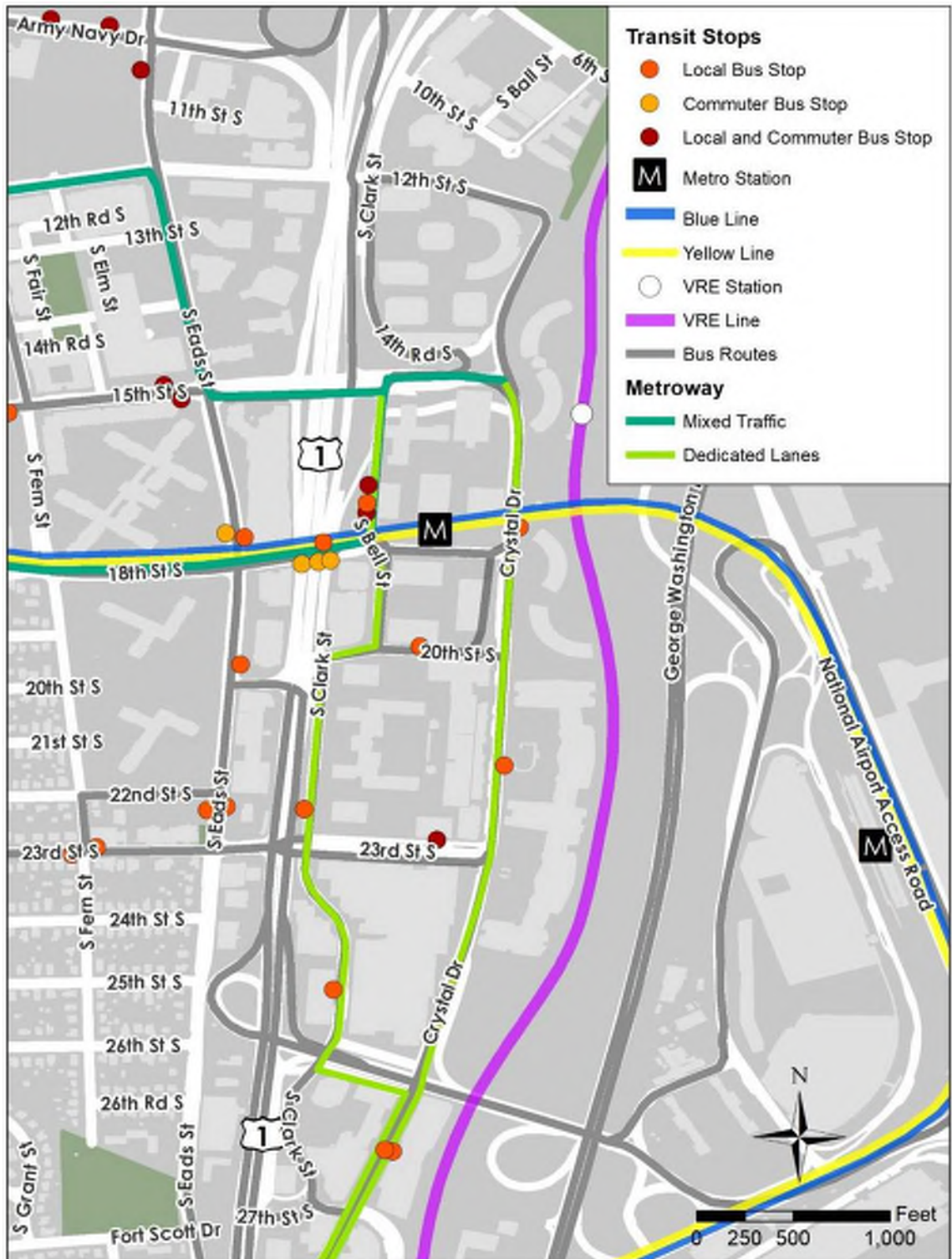


Figure 2-14: Existing Transit Stops and Routes

Table 2-4: Existing Route 1 Study Area Bus Service

Bus Route	Service Type	Approximate AM Peak Headway (minutes)	Approximate PM Peak Headway (minutes)
ART 43	Local	10	10
WMATA Metrobus 10A	Local	30	30
WMATA Metrobus 23B	Local	25	~25
WMATA Metrobus MW1	Local	8	8
Fairfax Connector 599	Commuter	30	25
WMATA Metrobus 7A	Local	30	30
WMATA Metrobus 7F	Local	30	30
WMATA Metrobus 7Y	Local	30	-
WMATA Metrobus 23A	Local	24	15
WMATA Metrobus 22A	Local	60	60
LCT 282	Commuter	30	-
LCT 482	Commuter	30	-
LCT 682	Commuter	-	120
LCT 882	Commuter	-	30
Omni-Ride L-200	Commuter	25	25-30

Measures of Effectiveness

Bus transit service routes and stops, including service provided by Metrobus, ART, Fairfax Connector, OmniRide, and LCT, were included within the Vissim model. This includes modeling of all bus headways and dwell times, as well as transit signal priority at relevant intersections, including those along the Metroway service along Crystal Drive.

The following transit performance measures were collected for the study area:

- Bus delay at intersections
- Bus travel times within the network

Bus Delay at Intersections

The average intersection delays for transit at critical study intersections were measured throughout the Vissim model. **Appendix D** summarizes intersection delay by mode type and includes a tabulation of intersection movements that contribute to transit delay. Similar to vehicular delay trends, the AM peak hour experienced the greatest intersection delays, especially around 20th and 23rd Street.

The greatest AM transit delays were experienced at the following intersections:

- 15th Street S and Route 1: southbound left turn (60 s)
- Route 1 and 20th Street S/S Clark Street cluster: westbound left turn to S Clark Street (49 s)
- Route 1 and 23rd Street S/S Clark Street/S Eads Street cluster:
 - Southbound approach from S Clark Street (171 s)
 - Eastbound through movement from 23rd Street S at S Eads Street (178 s) and at Route 1 (83 s)

The greatest PM delays were experienced at the following intersections:

- 15th Street S and Route 1: southbound left turn (84 s)
- Route 1 and 20th Street S/S Clark Street cluster: westbound left turn to S Clark Street (58 s)
- Route 1 and 23rd Street S/S Clark Street/S Eads Street cluster:
 - Southbound approach from S Clark Street (100 s)
 - Westbound through movement from 23rd Street S at Route 1 (62 s)

Bus Travel Times

Average travel times for representative bus routes between entry and exit points to the modeled network were identified and measured through the Vissim model. Transit travel times describe the total time it takes for each route to enter the study area, travel along its route, stop where designated, and then exit the study area. **Appendix D** summarizes the results for each route.

2.3.4. Existing Pedestrian Infrastructure and Operations

Pedestrian Infrastructure and Demand

The pedestrian study area consists of intersections along Route 1 and immediately adjacent to Route 1, also known as the Core Street Study Area, and includes sidewalks, crosswalks, and trails. The study area currently has an extensive sidewalk network in place, accommodating both sides of the roads with facilities for most of the roadways. Crosswalks are also available at every signalized intersection for most crossings. **Figure 2-15** illustrates the location for pedestrian facilities that were analyzed for the study.

Pedestrian counts at all study area intersections and crosswalks were provided by Arlington County and reflected in the Route 1 Vissim model. In cases where the Arlington County PDSP model did not include a pedestrian crosswalk and field data was unavailable, pedestrian demand was inferred from surrounding intersections. **Figure 2-15** also shows the AM and PM peak hour pedestrian counts at critical intersections. The most significant pedestrian volumes are seen at the Route 1 and 23rd Street S/S Clark Street intersection cluster, as it provides access to various restaurants along 23rd Street S and Crystal Drive. Significant pedestrian volumes are also observed along 18th Street S under the existing Route 1 overpass; one of the pedestrian entrances to the Crystal City Metrorail station is located just to the east of this overpass.



Pedestrian Crossing at Route 1 Offramp to 15th Street S

AM/PM Peak Hour Pedestrian Volume

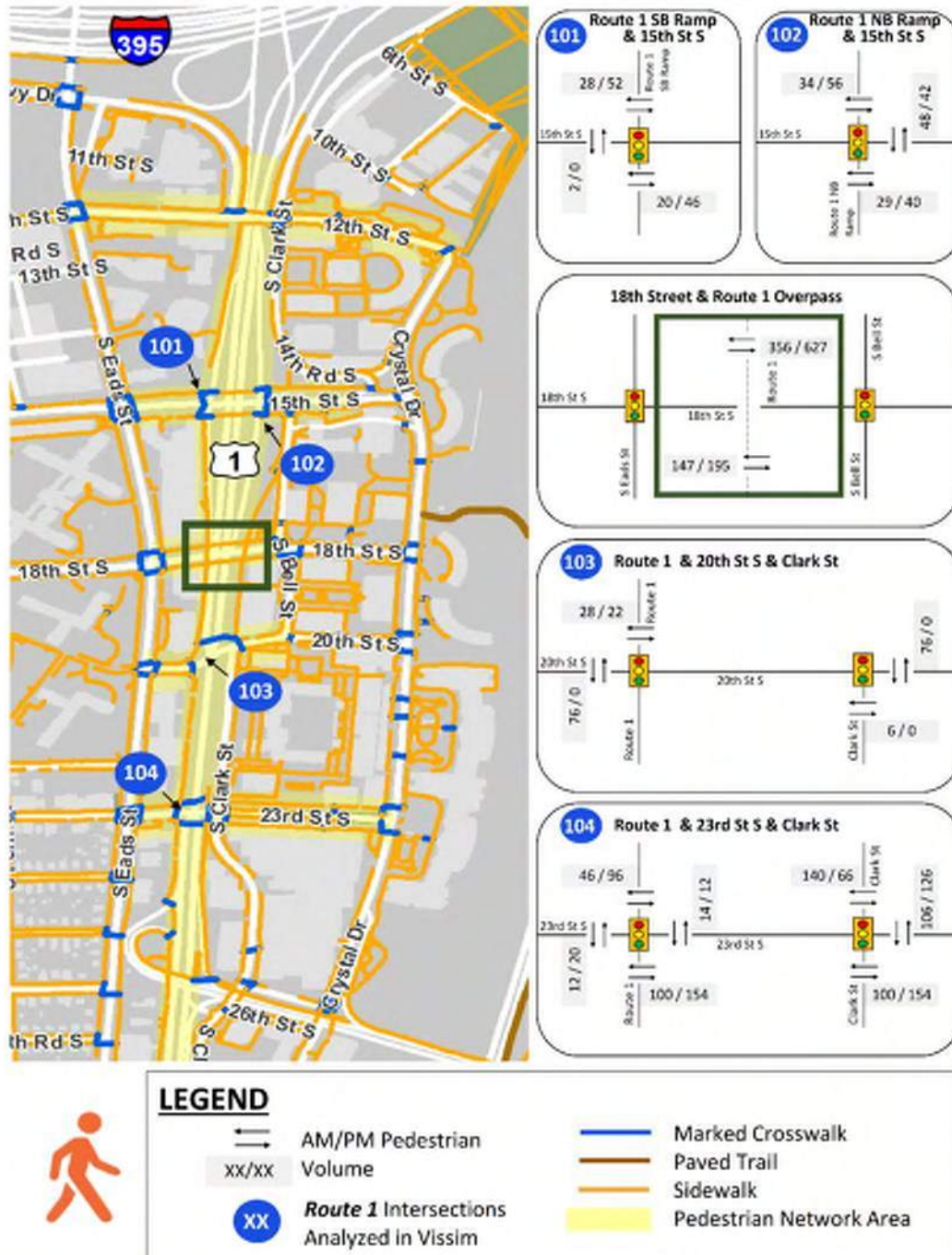


Figure 2-15: Pedestrian Network and AM and PM Peak Hour Pedestrian Volumes

Measures of Effectiveness

The following MOEs were used for the pedestrian multimodal analysis:

- Pedestrian Crossing Distance
- Number and Type of Crosswalks
- Pedestrian Experience and Comfort
- Pedestrian Delay at Intersections

Pedestrian Crossing Distance

Table 2-5 summarizes the distance required to cross Route 1 and the side streets within the Core Street Study Area, including pedestrian refuges. Many locations along the Core Street Study Area require pedestrians to wait at a pedestrian refuge to safely cross. Pedestrian refuge areas only have capacity to hold a few pedestrians, and two-stage crossings increase pedestrian delay significantly.

Table 2-5: Existing Pedestrian Crossing Distance and Timings

Intersection	Crossing Route 1		Crossing Side Street	
	Crossing Distance (ft)	Median Refuge	Crossing Distance (ft)	Median Refuge
Southbound Route 1 Ramps and 15th Street S	50	-	130	Yes
Northbound Route 1 Ramps and 15th Street S	45	-	140	Yes
Route 1 and 20th Street S / S Clark Street	100	Yes	90	Yes (West Side)
Route 1 and 23rd Street S / S Clark Street	185*	Yes	115	Yes (East Side)

* The crossing distance includes crossing S Clark Street since this movement is included in the pedestrian phase timings.

Number and Type of Crosswalks

For the study, the number of crosswalks were quantified. **Figure 2-15** illustrated the location for marked crosswalks that were within the Crystal City area. **Table 2-6** summarizes the type of crosswalk at the intersections in the Core Street Study Area.

Table 2-6: Existing Pedestrian Crossing Types

Intersection	Crossing Route 1:		Crossing Side Street:	
	Northern Leg	Southern Leg	Eastern Leg	Western Leg
Southbound Route 1 Ramps and 15th Street S	High Visibility	High Visibility	none	High Visibility
Northbound Route 1 Ramps and 15th Street S	High Visibility	High Visibility	High Visibility	none
Route 1 and 20th Street S / S Clark Street	High Visibility	none	High Visibility	High Visibility
Route 1 and 23rd Street S / S Clark Street	High Visibility*	High Visibility*	Standard Longitudinal with Brick Pattern	Standard Longitudinal with Brick Pattern

* The crosswalk crossing S Clark Street at the intersection with 23rd Street S is standard with longitudinal with brick pattern

Pedestrian Experience and Comfort

In Arlington County, commercial business parcels encompass most of the sidewalks along VDOT and County streets. Therefore, majority of the sidewalks are not within the public right-of-way. In order to evaluate the pedestrian experience and comfort within the study area, an inventory of existing sidewalk widths within the study area and public space (via easements) was identified. Pedestrian experience and comfort are increased with wider available pedestrian facilities; therefore, the width of existing sidewalks is used to measure this MOE.

Figure 2-16 illustrates the sidewalk widths along each block of the pedestrian network area. The maximum width of the sidewalk was identified for each sidewalk segment. All sidewalks have widths greater than 4 feet. There is no sidewalk adjacent to northbound Route 1 (east side of Route 1) north of 18th Street S; this location is where the S Clark Street overpass was recently removed.

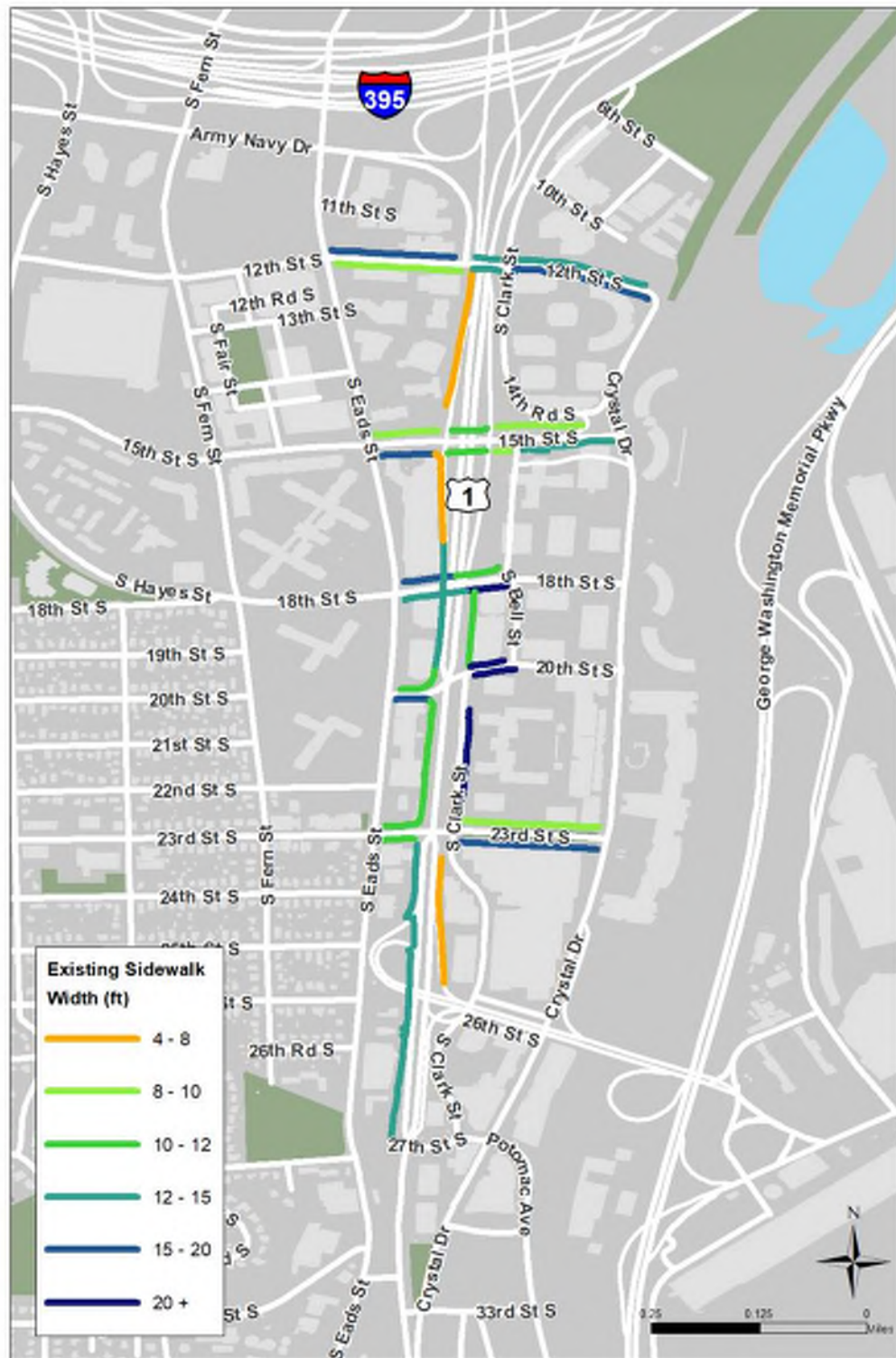


Figure 2-16: Existing Sidewalk Width

Pedestrian Delay at Intersections

Figure 2-17 summarizes the average AM and PM pedestrian delays per intersection approach. Similar to the traffic delays, the Route 1/20th Street/Clark Street intersection and the Route 1/23rd Street/Clark Street intersection experience high delays for pedestrians. Some of these delays are due to two-stage crossings (both across Route 1 and across 23rd Street S on the east side of Route 1); additionally, the long cycle lengths at these intersections results in high delay, especially for side-street (east-west) pedestrian movements. There are also high delays for pedestrians crossing 15th street at the intersections with the Route 1 interchange ramps. Overall, in the AM scenario, there are six pedestrian movements with delays over 100 seconds. Likewise, in the PM scenario, there are five movements with delays over 100 seconds. Due to lower pedestrian volumes at some intersections, it should be noted that random arrivals of pedestrians may have a significant influence on reported delay values.

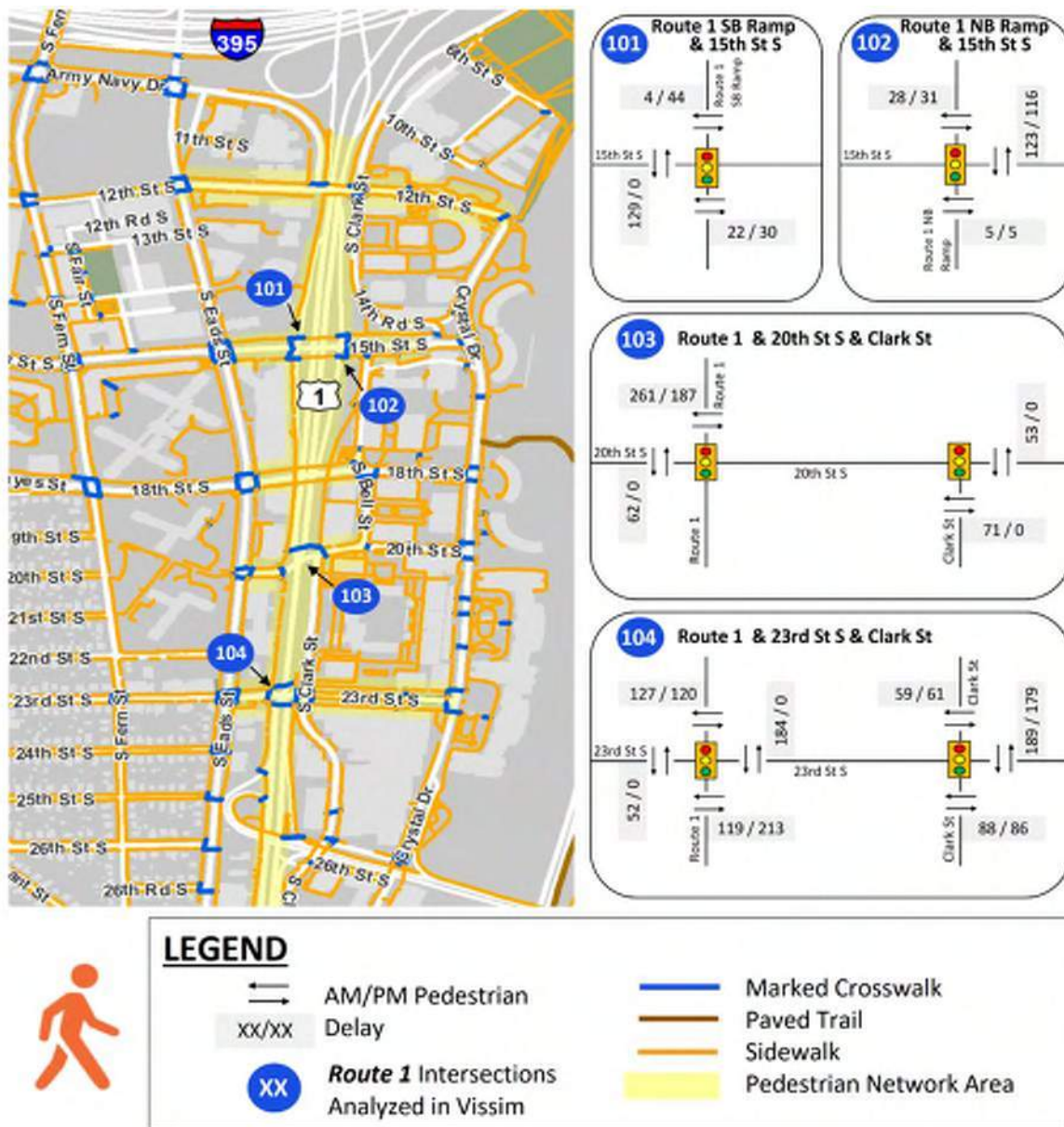


Figure 2-17: Existing AM/PM Peak Hour Pedestrian Delay

2.3.5. Existing Bicycle Infrastructure and Operations

Infrastructure and Usage

The bicycle study area consists of intersections along Route 1 and immediately adjacent to Route 1, also known as the Core Street Study Area. Throughout the study area, there are on-street bike lanes and other facilities. Route 1 is in proximity to regional trails such as the Four Mile Run and Mount Vernon Trail. In general, bike lanes are most present near the Crystal City Metrorail station, providing facilities for bicyclists to ride north-south and east-west of the station. Bicycle accommodations are not provided along Route 1, which is a limited-access freeway north of 20th Street S. **Figure 2-18** illustrates the location for bicycle facilities (on-street facilities and off-street trails), as well as the locations for Capital Bikeshare stations.

The Arlington County PDSP Vissim model, which encompasses a much larger area, did not include bicycle facilities or inputs. For the Route 1 Vissim model, bicycle demand volumes were determined from the additional October 2019 data provided by Arlington County. In locations where bicycle counts were unavailable, demand was inferred from immediately adjacent locations.

Measures of Effectiveness

The following MOEs were used for the bicycle multimodal analysis:

- Bicycle Level of Traffic Stress (BLTS)
- Bicycle Delay at Intersections
- Bicycle Travel Times along Key Routes



Bicycle Lane on 18th Street S

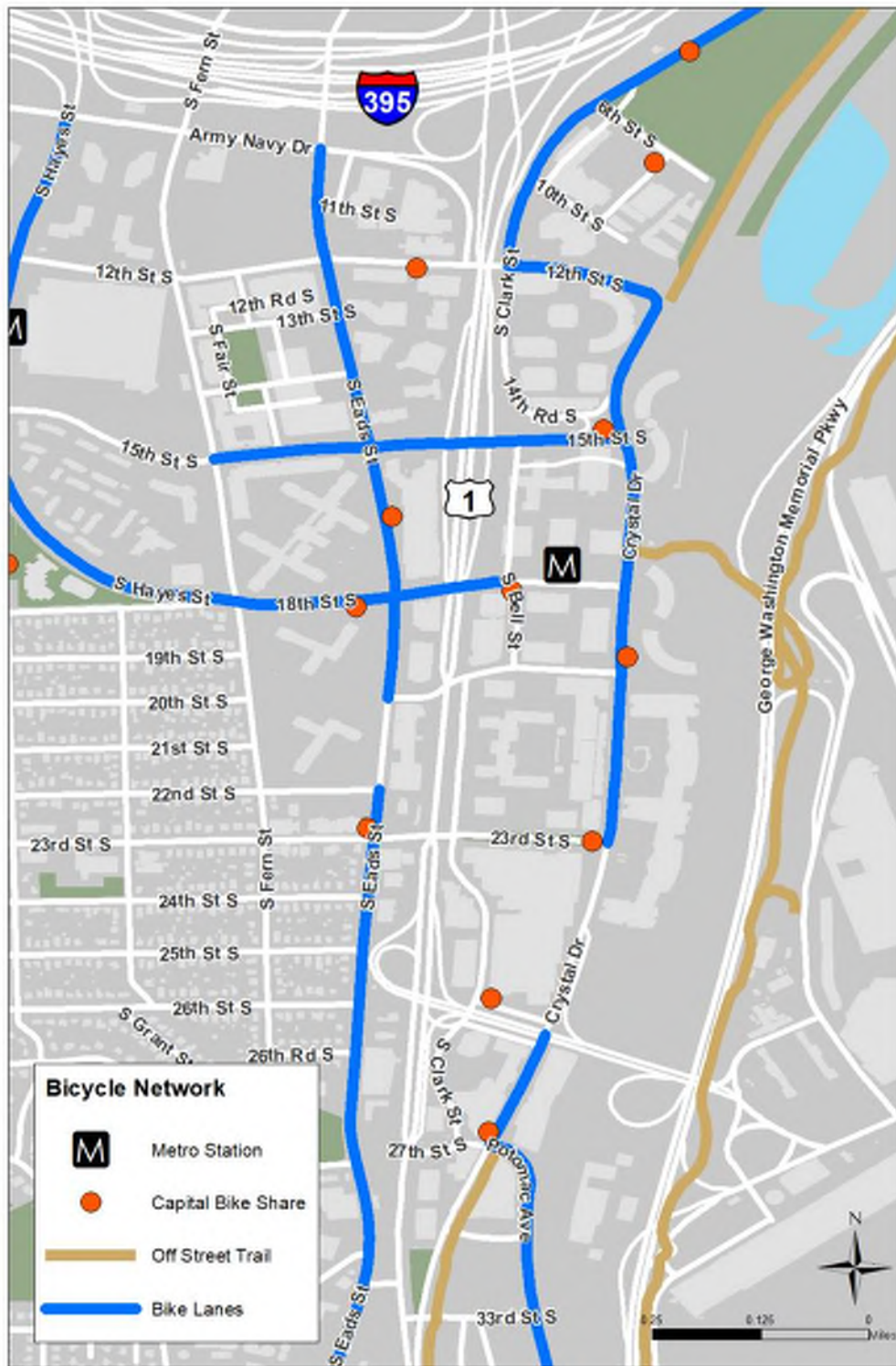


Figure 2-18: Existing Bicycle Network

Bicycle Level of Traffic Stress

To better understand the perceived comfort for bicyclists around the Route 1 study area, cross-streets were assessed with a methodology called Bicycle Level of Traffic Stress (BLTS). As no bicycles are allowed along Route 1, cross-streets were analyzed for their segments that were within one block from Route 1. The methodology used for this analysis was developed by the Mineta Transportation Institute in 2012 and updated in June 2017².

BLTS is a rating given to a road segment or crossing indicating the traffic stress it imposes on bicyclists. BLTS is represented as a numerical score from 1 to 4, with 1 being the “lowest stress” and 4 being the “highest stress”. These ratings are assigned based on factors influencing bicyclist comfort, such as bicycle facility type and width, traffic speeds and volumes, number of vehicular travel lanes, and presence of on-street parking. The combination of these factors contributes to the level of stress that a bicyclist may feel as they travel along a city street. Descriptions defining each BLTS score are provided below.

- **BLTS 1:** Strong separation from all except low speed, low volume traffic. Simple crossings. Suitable for children.
- **BLTS 2:** Except in low speed / low volume traffic situations, cyclists have their own place to ride that keeps them from having to interact with traffic except at formal crossings. Physical separation from higher speed and multilane traffic. Crossings that are easy for an adult to negotiate.
- **BLTS 3:** Involves interaction with moderate speed or multilane traffic, or proximity to higher speed traffic.
- **BLTS 4:** Involves interaction with higher speed traffic or proximity to high speed traffic.

As shown in **Figure 2-19**, a street with a BLTS score of 1 provides a comfortable and low-stress riding experience for bicyclists of all ages and abilities. On the other end of the spectrum, a street with a score of 4 facilitates a low-comfort and high-stress environment of which only bicyclists classified as strong and fearless could reasonably be expected to utilize.

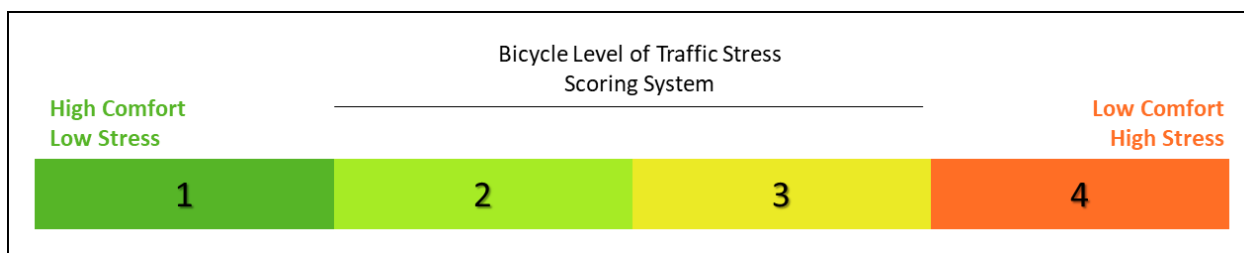


Figure 2-19: BLTS Scoring System

Streets with bicycle facilities are not guaranteed high scores. The scoring methodology considers contributing factors such as street width, traffic volumes, and the presence of on-

² <http://www.northeastern.edu/peter.furth/research/level-of-traffic-stress/> (Introduction); <http://www.northeastern.edu/peter.furth/wp-content/uploads/2014/05/LTS-Tables-v2-June-1.pdf> (Updated Methodology)

street parking. Within this study area, potential for conflicts from on-street parking contributed to a higher stress environment for bicyclists. For example, streets with dedicated bike lanes can receive BLTS scores between 2 and 3 when adjacent on-street parking is present and physical protection is absent.

Within the study area, streets were segmented from intersection to intersection directionally to determine the most appropriate BLTS score. For example, the BLTS score for a side street going westbound may be different than for the segment going eastbound, as scores depend on the available facilities and roadway characteristics. The study area BLTS scores were computed using the segment lengths for each BLTS score.

Figure 2-20 shows the location by street segment for each BLTS score. Overall, there was one segment in the study area that experiences a BLTS of 1: along eastbound 12th Street S from Long Bridge Drive to Crystal Drive. This segment has a bike lane not adjacent to parking with one through lane along a 25 mph road. The majority of the other crossing street segments were assigned a BLTS score of 2 or 3. Most of the segments scoring a BLTS 3 were due to the mixed traffic facilities where bicyclists share the road with traffic. These roads generally had volumes greater than 3,000 vehicles per day directionally. Those segments scoring a BLTS 2 were mostly those containing bike lanes adjacent to parking, two through lanes, and speeds of 25 mph. Notably, 18th Street S, which passes underneath of Route 1 and does not provide any access to or from Route 1, has a lower BLTS than the parallel crossings of Route 1. Dedicated bike lanes are provided in each direction along 18th Street S, which provides access to the Crystal City Metrorail station.

Note that the Route 1 corridor north of 20th Street S falls within the “No Facility” category in which bicyclists are not allowed access.

Bicycle Delay at Intersections

Bicycle counts provided by Arlington County were incorporated into the Route 1 study Vissim model and Core Street Study Area intersections were analyzed for bicycle delays. The average bicycle delay at each intersection was collected and analyzed following a similar methodology as the vehicular Vissim results where an analogous HCM delay-based LOS threshold at signalized intersections was used. **Appendix D** provides a detailed summary for all the Core Street Study Area bicycle delays at intersections.

Bicycle Travel Times along Key Routes

Bicycle travel times for east/west travel along 15th Street S and 18th Street S were measured in the Vissim model. **Appendix D** provides a detailed summary for the key bicycle travel times.

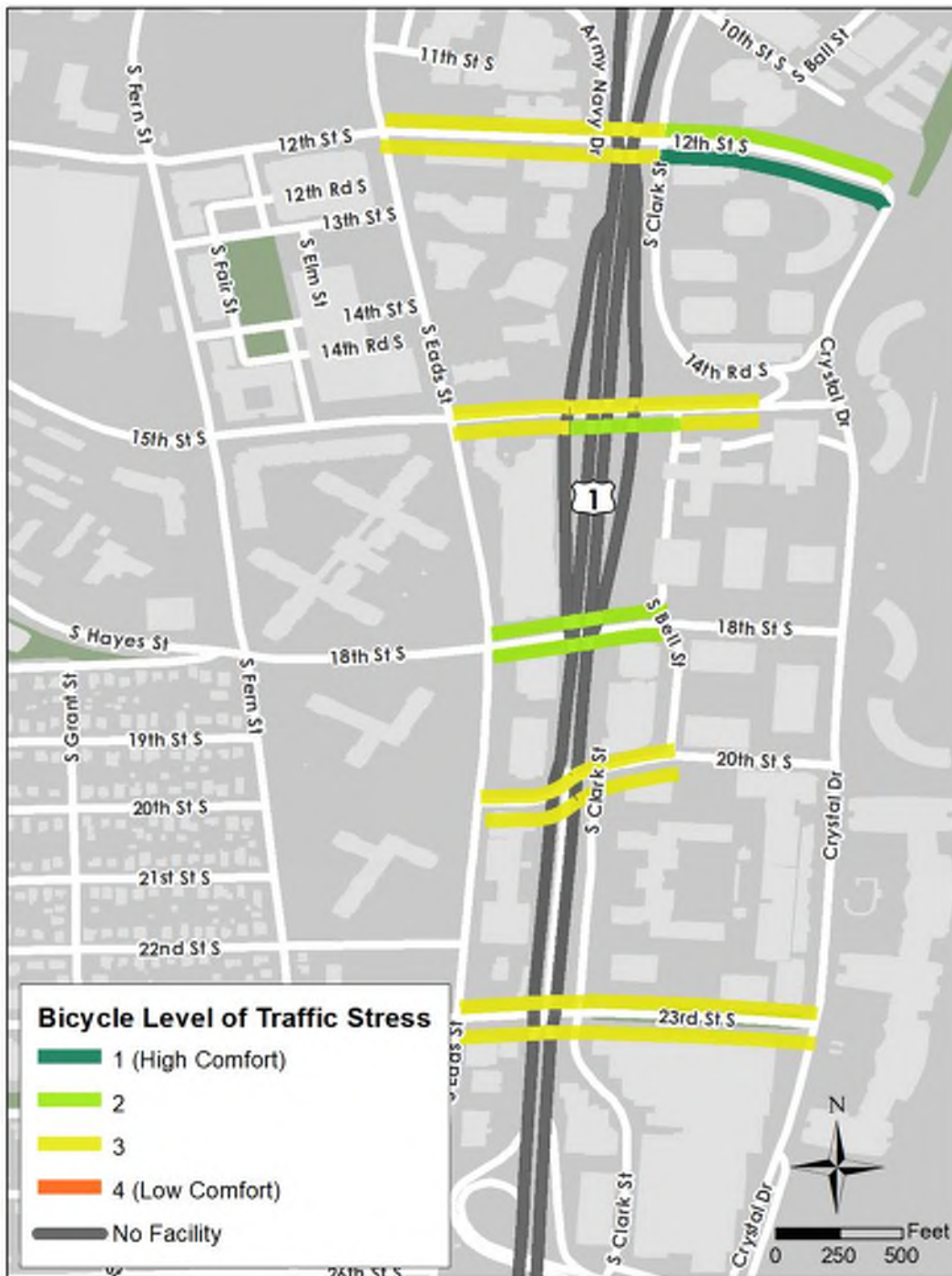


Figure 2-20: Study Area BLTS

2.4. HISTORICAL CRASH ANALYSIS

An existing crash analysis was conducted by utilizing crash data from the Virginia Roads VDOT crash database from January 1, 2015 to February 28, 2020. This time period was selected to gather the most recent five years of crash data prior to the COVID-19 pandemic. Crash data from the selected time period was isolated for the project study area and broken down into two separate groups:

- Route 1 Mainline Corridor Crashes
- Core Street Study Area Signalized Intersections Crashes

The Route 1 mainline crashes consisted of crashes occurring along Route 1 from I-395 to south of Route 233 that did not include incidents occurring directly along ramps (starting from the ramp gore) or crashes in the immediate vicinity of signalized intersections. The mainline crashes were solely those occurring on the Route 1 corridor, as shown in **Figure 2-21**. Separately, the crashes associated with the intersections were those within a 250 feet buffer of the intersection or within the intersection's influence area. An influence area of an intersection extends to the beginning of a storage bay or turning lane to account for all vehicular traffic volumes approaching the intersection.

The Core Street Study Area signalized intersections consisted of four intersections:

- Route 1 southbound ramps and 15th Street S intersection
- Route 1 northbound ramps and 15th Street S intersection
- Route 1 and 20th Street S/S Clark Street intersection cluster
- Route 1 and 23rd Street S/S Clark Street intersection cluster

For both groups, crashes were analyzed based on crash type, severity, weather condition, light condition, time of day, and day of the week. In summary, there were 125 total crashes combined along the Route 1 mainline corridor and at the four Core Street Study Area intersections. **Table 2-7** provides the total study area crash summary by year and severity. There were no fatalities in the area and about one-third of the crashes resulted in injuries, with the rest being property-damage-only (PDO). Injury crashes are classified at three different levels: severe injury (Class A), visible minor injury (Class B), and possible injury (Class C). There were three severe injuries and 40 visible injuries; no possible injuries were reported. Note that the number of crashes in the study area has generally trended down over the past five years. There was a significant decrease in crashes from 2016 to 2017, reducing by one-half. Much of the crash reduction occurred at the interchange of the Route 1 and 15th Street S ramps. This area had 13 crashes in 2016 but only two crashes in 2017. It is unclear whether this is attributable to statistical anomaly or changes to the built environment (e.g., construction associated with the removal of the S Clark Street overpass).

Table 2-7: Total Study Area Crash Summary

Year	Severity				Total
	Fatality	Severe Injury	Visible Injury	PDO	
2015	0	1	9	25	35
2016	0	2	11	19	32
2017	0	0	6	10	16
2018	0	0	7	15	22
2019	0	0	5	12	17
2020 ¹	0	0	2	1	3
Total	0	3	40	82	125

1 Crash data for 2020 was only collected between January 1, 2020 to February 28, 2020

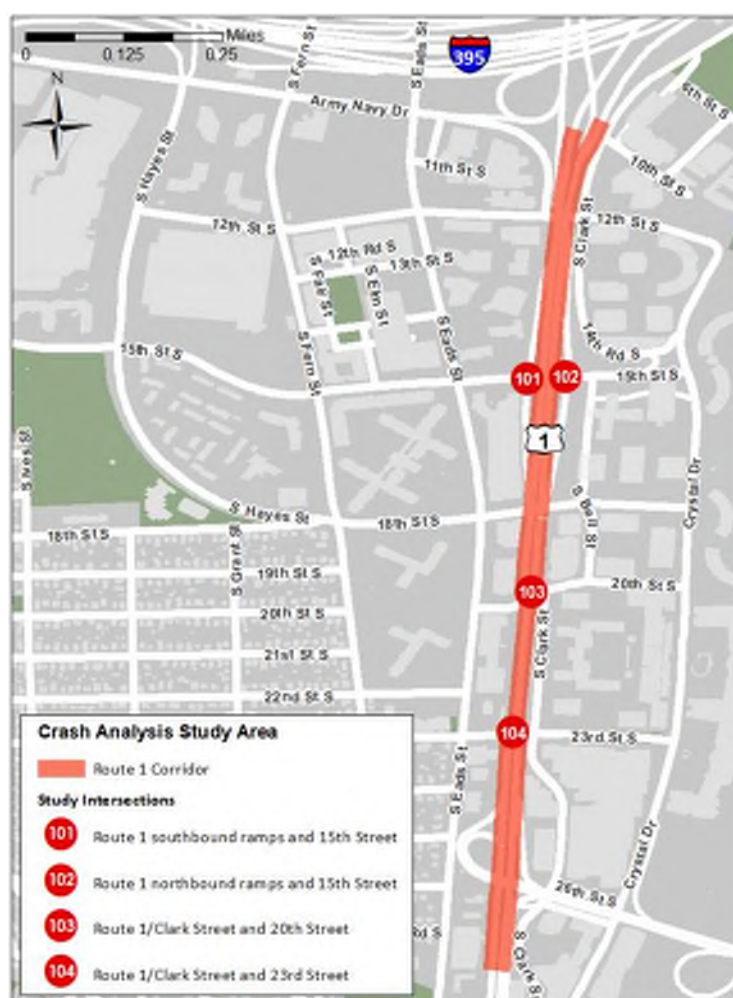


Figure 2-21: Crash Analysis Study Area

2.4.1. Route 1 Mainline Corridor Crashes

Over the analysis period for which crash data was collected, there were a total of 38 reported crashes along the Route 1 mainline outside of the Core Street Study Area intersections. A summary of the crash frequency by year and travel direction is provided in **Table 2-8**, and **Table 2-9** summarizes the crash severities by direction. A summary of crashes by type is provided in **Table 2-10** and **Figure 2-22**.

As shown, 20 more crashes occurred in the southbound direction as compared to the northbound direction. Of these crashes, there were no fatalities reported during the analysis period, and the majority (66 percent) were PDO crashes. About a third of the total crashes involved injuries. Additional crash details for the Route 1 corridor are provided in the following sections and in **Appendix E**.

Table 2-8: Route 1 Mainline Crash Frequency by Year and Direction

Location	Number of Crashes						Total
	2015	2016	2017	2018	2019	2020 ¹	
Northbound Route 1	4	2	0	2	1	0	9
Southbound Route 1	9	10	3	4	2	1	29
Total	13	12	3	6	3	1	38

¹ Crash data for 2020 was only collected between January 1, 2020 to February 28, 2020.

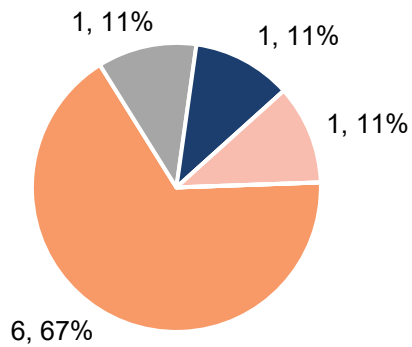
Table 2-9: Route 1 Mainline Crash Severity

Location	Number of Crashes			Total
	Fatality	Injury	PDO	
Northbound Route 1	0	1	8	9
Southbound Route 1	0	12	17	29
Total	0	13	25	38

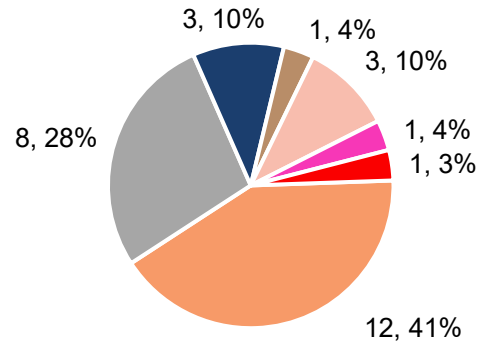
Table 2-10: Route 1 Mainline Crash Type

Location	Type of Crash							Total
	Rear end	Angle	Sideswipe (same direction)	Fixed Object (in road)	Fixed Object (off road)	Pedestrian / Bicycle	Other	
Northbound Route 1	6	1	1	0	1	0	0	9
Southbound Route 1	12	8	3	1	3	1	1	29
Total	18	9	4	1	4	1	1	38

Northbound Crashes by Type



Southbound Crashes by Type



* Labels: Number of crashes, percent of total directional crashes

Figure 2-22: Route 1 Mainline Crash Type Pie Chart by Direction

The predominant crash type was rear end (47 percent), followed by angle (24 percent). There were more rear end and angle crashes occurring in the southbound direction than in the northbound Route 1 direction. The only pedestrian crash occurred south of the Route 233 interchange at a driveway.

Crash activity along the corridor for the northbound and southbound Route 1 corridor is shown on a map in **Figure 2-23**. As illustrated, the northbound direction experiences majority of the crashes near the I-395 interchange ramp area, whereas the majority of crashes in the southbound direction are located near Route 233 and between I-395 and 15th Street S.

- In the northbound direction, there is a weave area between the on-ramp from 15th Street S and the split to go to either northbound Route 110 or northbound I-395, which may contribute to the increase in crashes along that area. The types of crashes occurring near the I-395 interchange are rear ends, angle, sideswipe (same direction), and fixed objects (off road) – crash types that could result from vehicles making last-minute lane changes. Additionally, during the AM peak period, this location experiences heavy mainline traffic due to queue spillback from I-395 entering Washington, DC.
- In the southbound direction, the greatest number crashes are experienced near the Route 233 interchange. Southbound Route 1 has a choice lane leading to the off-ramp to Route 233; the on-ramp has a very short merge lane of about 300 feet signed for drivers to yield. The crash types experienced in this area are mostly rear end, angle, and sideswipe (same direction). The highest number of angle crashes in the study area occur at this location, likely due to traffic from the on-ramp merging with the mainline Route 1 traffic.
- Southbound Route 1 also experiences a high number of crashes along the mainline between 12th Street S and 15th Street S. This stretch has a short weave segment between where Route 110 and I-395 on-ramps merge into Route 1 and the southbound Route 1 off-ramp exits to 15th Street. The gore-to-gore weave segment is less than 350 feet, which likely contributes to high number of crashes occurring.

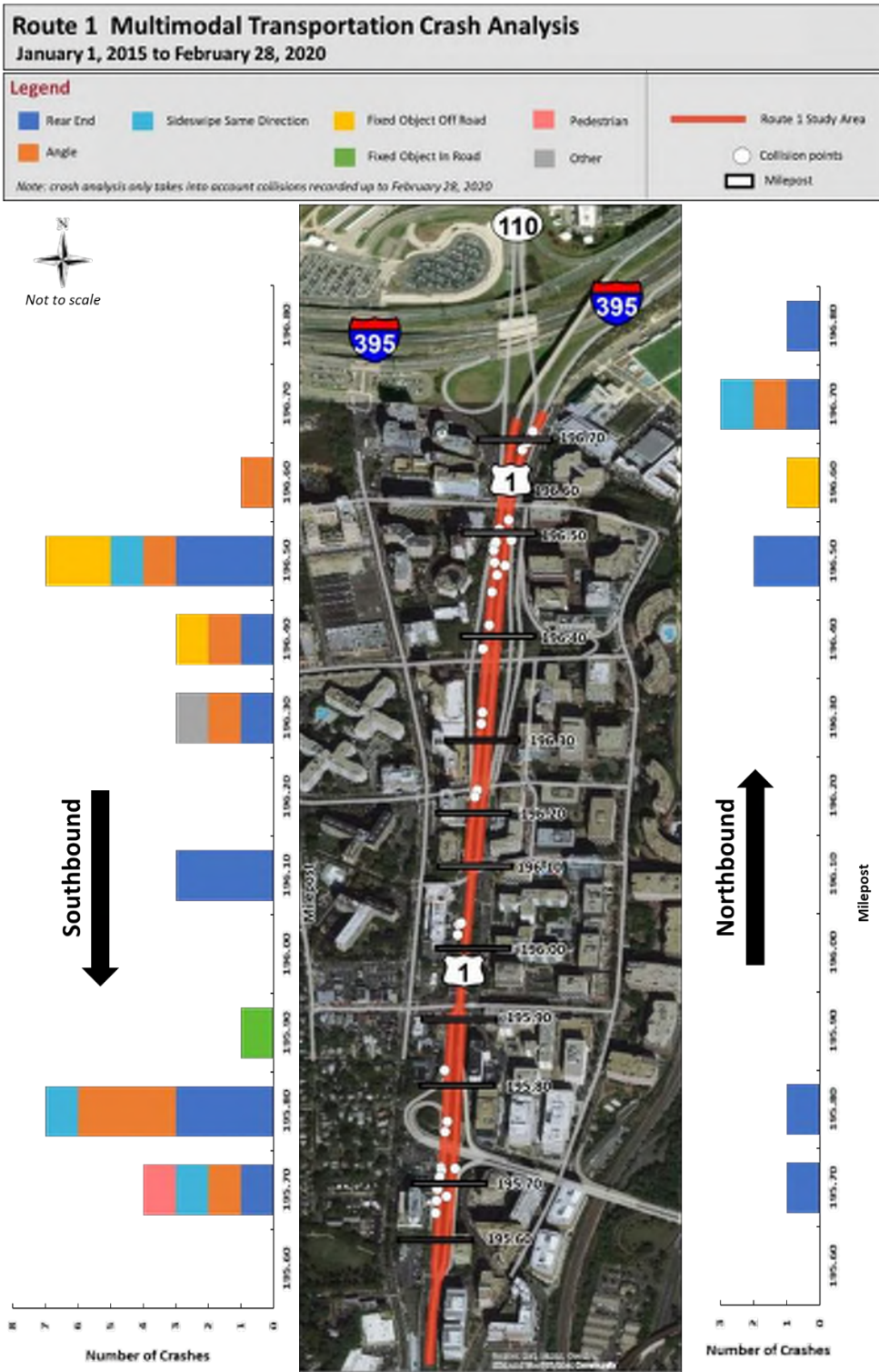


Figure 2-23: Route 1 Mainline Crash Analysis Histogram

2.4.2. Core Street Study Area Signalized Intersection Crashes

Crashes at four signalized intersections were analyzed for this study. These intersections are within the Core Street Study Area and were identified as intersections that may be affected in future proposed alternatives. **Table 2-11** summarizes the total number of crashes per year for each intersection.

Table 2-12 summarizes the intersection crashes by severity. **Table 2-13** breaks down the number of crashes by crash type for each intersection.

The two study area intersections with the highest number of crashes were the Route 1 and 20th Street S/S Clark Street cluster and Route 1 and 23rd Street S/S Clark Street cluster, with 35 and 38 crashes respectively. The 23rd Street cluster experienced the greatest number of pedestrian crashes, with seven crashes (18 percent) at this intersection involving pedestrians. It is a signalized intersection with pedestrian push buttons and a median refuge for crosswalks across Route 1. This intersection also experiences a high number of angle crashes (45 percent), which may be due to the complicated geometry that ties together Route 1, 23rd Street S, and S Clark Street. All intersections show similar crash trends, where the most prominent collision types are rear end and angle crashes.

None of the study intersections are listed under VDOT's 2014-2018 Potential for Safety Improvements (PSI) list. This PSI list identifies the top 100 intersections in Northern Virginia based on crashes and does an initial screening to identify which locations have a historically high number of crashes when compared to other intersections with similar volumes and geometry. Though not on the PSI list, the Route 1 intersections at 20th and 23rd Streets experience high numbers of rear end crashes and pedestrian crashes that could be addressed with future signal and geometric improvements. Individual crash summary sheets for each of the four intersections analyzed can be found in **Figure 2-24** through **Figure 2-27**.

Table 2-11: Intersection Crashes by Year

Location	Number of Crashes						Total
	2015	2016	2017	2018	2019	2020 ¹	
Southbound Route 1 ramps and 15th Street S	4	1	1	2	2	0	10
Northbound Route 1 ramps and 15th Street S	0	4	0	0	0	0	4
Route 1 and 20 th Street S / S Clark Street	12	8	6	5	4	0	35
Route 1 and 23 rd Street S / S Clark Street	6	7	6	9	8	2	38
Total	22	20	13	16	14	2	87

¹ Crash data for 2020 was only collected between January 1, 2020 to February 28, 2020

Table 2-12: Intersection Crashes by Severity

Location	Number of Crashes			Total
	Fatality	Injury	PDO	
Southbound Route 1 ramps and 15th Street S	0	3	7	10
Northbound Route 1 ramps and 15th Street S	0	3	1	4
Route 1 and 20 th Street S / S Clark Street	0	10	25	35
Route 1 and 23 rd Street S / S Clark Street	0	14	24	38
Total	0	30	57	87

Table 2-13: Intersection Crashes by Type

Location	Type of Collision									Total
	Rear End	Angle	Sideswipe (opposite direction)	Sideswipe (same direction)	Fixed Object (in road)	Fixed Object (off road)	Pedestrian/ Bicycle	Head On	Other	
Southbound Route 1 ramps and 15th Street S	3	3	1	2	0	1	0	0	0	10
Northbound Route 1 ramps and 15th Street S	1	3	0	0	0	0	0	0	0	4
Route 1 and 20th Street S / S Clark Street	21	9	0	0	0	1	1	2	1	35
Route 1 and 23rd Street S / S Clark Street	9	17	0	2	0	2	7	0	1	38
Total	34	32	1	4	0	4	8	2	2	87

Crash Location and Analysis Summary – Southbound Route 1 Ramps and 15th Street S Intersection

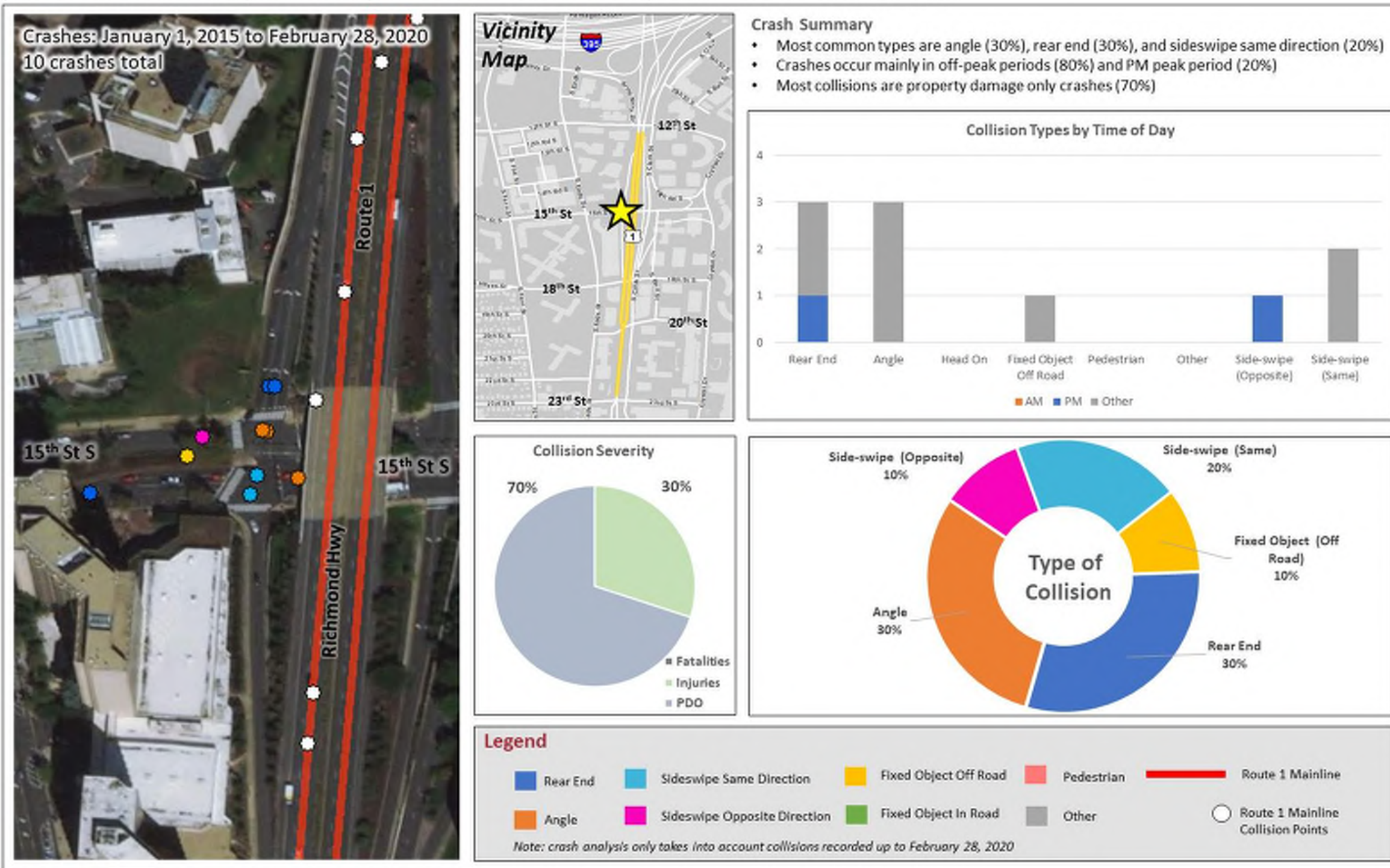


Figure 2-24: Intersection Crash Diagram – Route 1 Southbound Ramps and 15th Street S

Crash Location and Analysis Summary – Northbound Route 1 Ramps and 15th Street S Intersection

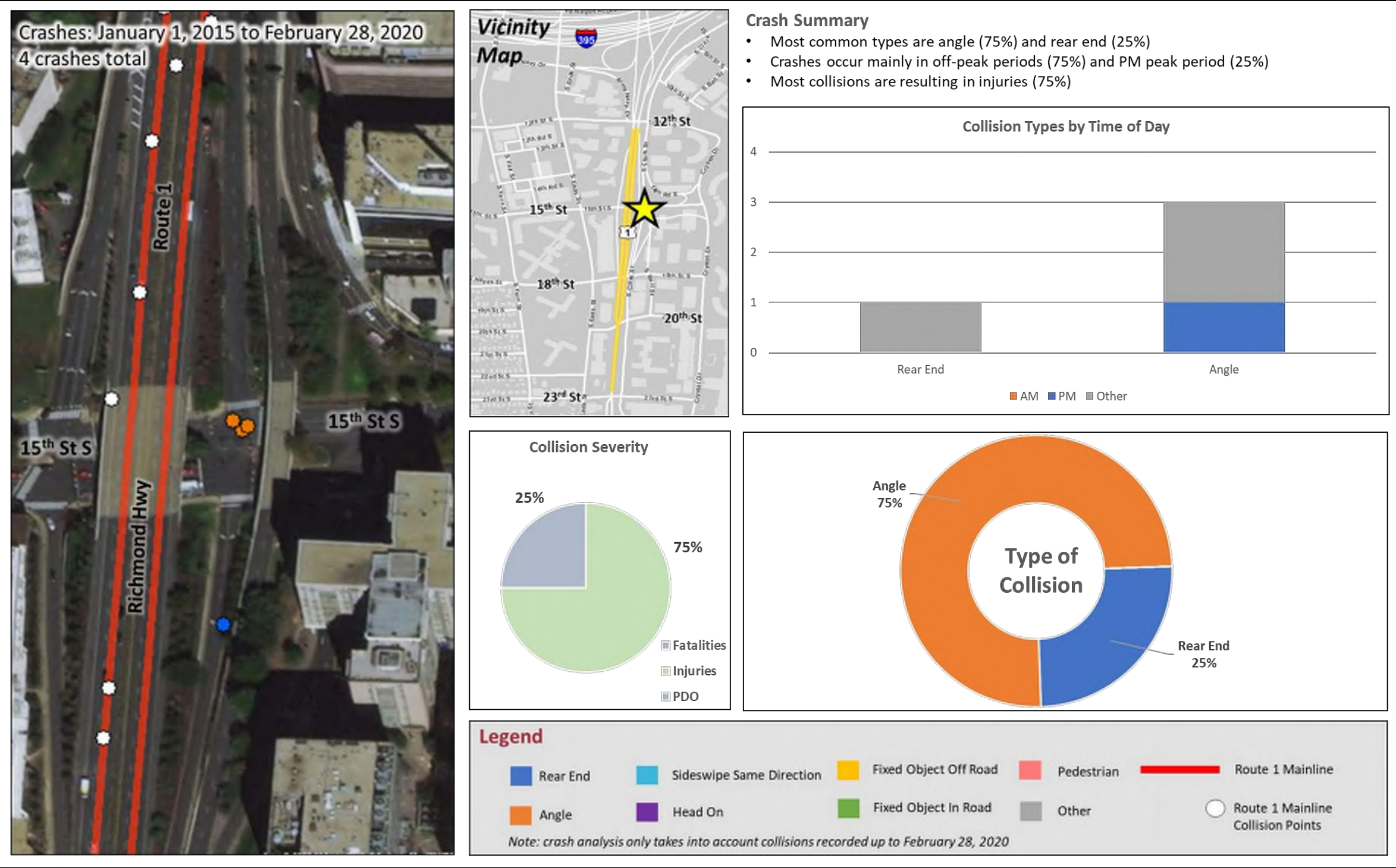


Figure 2-25: Intersection Crash Diagram – Route 1 Northbound Ramps and 15th Street S

Crash Location and Analysis Summary – Route 1 and 20th Street S / S Clark Street Intersection Cluster



Figure 2-26: Intersection Crash Diagram –Route 1/S Clark Street and 20 Street S

Crash Location and Analysis Summary – Route 1 and 23rd Street S / S Clark Street Intersection Cluster

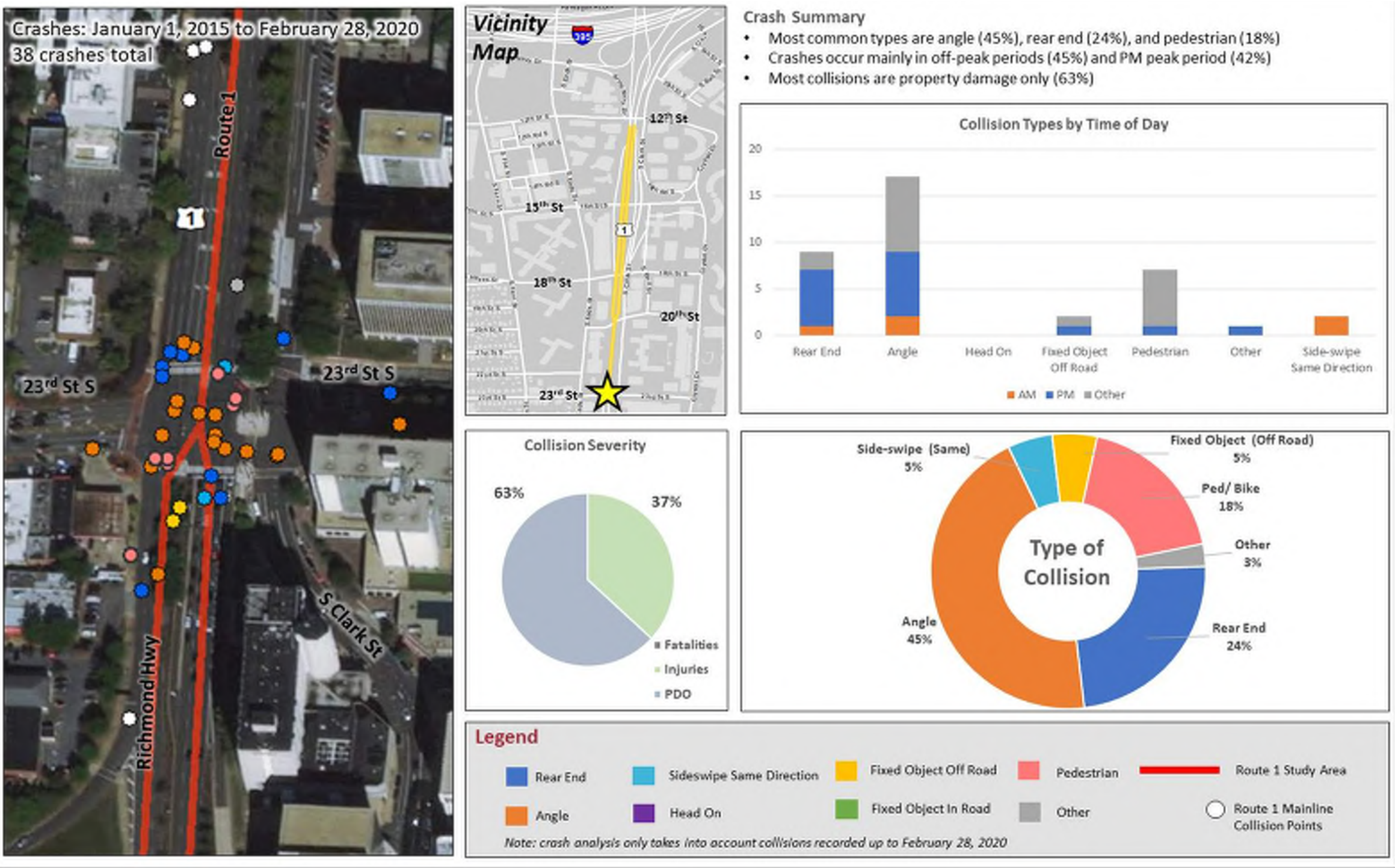


Figure 2-27: Intersection Crash Diagram –Route 1/S Clark Street and 23rd Street S

2.5. EXISTING ENVIRONMENT AND URBAN FORM

Crystal City is a unique built environment initially created in the 1960s considering access by the automobile. As the Metrorail system developed, with a station constructed in the heart of Crystal City, the built environment has more recently reflected transit-oriented development. Travel options have increased for access to and through Crystal City with a robust network of sidewalks, on- and off-street bicycle facilities, and a robust transit network. The current configuration of the Route 1 corridor from 23rd Street S to 12th Street S was constructed in the mid-1980s as part of a regional highway project that was truncated due to public opposition to a longer limited access facility. The corridor has evolved in the past 35 to 40 years as private land owners have developed parcels adjacent to Route 1 and as Arlington County has implemented multimodal street improvements outlined its 2010 Crystal City Sector Plan.

Along with this built environment, the County and private land owners have enhanced the natural, visual, and social environments in the vicinity of the study area with the construction of Long Bridge Park and its esplanade, playing fields, and passive recreation space; the reconstruction of Crystal Drive with more robust transit and bicycle facilities and sidewalks with room for restaurant seating; and the construction of open space areas such as the median on 15th Street S. east of Route 1. The built, natural, visual, and social environments all combine to create the urban form that exists today within the Route 1 corridor.



Demolition of S Clark Street Bridge – Arlington County project in early 2020 removed elevated S. Clark Street, creating opportunity for enhanced multimodal solutions and/or redevelopment that will front Route 1



Americana Motel front entrance altered by elevated Route 1, mid-1980s



Existing buildings with their backs (and emergency exits) along Route 1



Nearby Long Bridge Park (Phase I completed in 2011) enhances built, natural, visual, and social environments in Route 1 corridor

3. Existing Conditions Summary

The following summarizes the major findings from the Existing Conditions evaluation of the Route 1 Multimodal Improvements study area.

Existing Transportation Infrastructure

- From 23rd Street S to 12th Street S, Route 1 has 3 travel lanes in each direction carrying approximately 45,000 vehicles per day.
- The Route 1 corridor is currently a limited access freeway north of 20th Street S, with no vehicle access to existing buildings along this segment and limited to no pedestrian access to these buildings.
- In this segment of the corridor, Route 1 is grade separated and passes over 18th Street S and 15th Street S; interchange ramps provide access to 15th Street S.
- Between 23rd Street S and 20th Street S, S Clark Street runs parallel to Route 1.
- Route 1 has signalized intersections at both 20th Street S and 23rd Street S; these intersections also provide access to S Clark Street. Left turn lanes are provided in both directions along Route 1 at the intersections with 23rd and 20th Streets S, with dual left turn lanes for southbound Route 1 at 23rd Street S. Right turn lanes are provided at each of these intersections in the northbound direction along Route 1.
- Sidewalks of appropriate width (i.e., greater than 6 feet clear) exist along Route 1 between 23rd Street S and 20th Street S and along the cross streets of 20th, 18th, and 15th Streets S.
- Bicycle facilities exist on north-south routes parallel to Route 1, and bicycle lanes are provided on 15th Street S (eastbound) and on 18th Street S (both directions).
- The existing structures along the corridor are rated from fair to good condition. Based on the geotechnical review, extra care will be needed to protect building foundations for construction around 18th Street S. There is also potential for unsuitable soil between 12th Street S and 15th Street S and the possibility of subsurface water.
- There are four existing drainage outfalls and no existing public stormwater management facilities along the corridor. The existing drainage network is made up of underground pipes with curb inlets providing the primary source for runoff conveyance.
- The majority of the existing utilities along the Route 1 corridor are located underground to the east of the existing roadway pavement. Additional concentrations of existing utilities are located at the side street intersections with Route 1. There is a high probability of abandoned or unidentified utilities in this highly developed corridor.

Existing Vehicular Traffic Operations

- **Route 1 and 15th Street S interchange**
 - Very heavy turn volumes are associated with traffic between Pentagon City to the west and Route 1 north of the study area (eastbound left turns to the northbound on-ramp in the AM and southbound right-turns from the southbound off-ramp in the PM).
 - Due to these high demands, in the AM peak, the eastbound left turn to the northbound on-ramp sees queue spillback through the intersection with the southbound ramps and occasional queue spillback blocking the eastbound 15th Street S through movements. During the PM peak, the southbound off-ramp queues occasionally reach the Route 1 freeway mainline.

- **Route 1 and 20th Street S/S Clark Street intersection cluster**
 - This intersection cluster, along with the Route 1 intersection at 23rd Street S, provides access to the adjacent S Clark Street frontage road, and runs split-phased to accommodate turns onto (and, in the case of 23rd Street S, off of) S Clark Street. This means that the eastbound and westbound movements are unable to run at the same time, despite relatively low volumes. These additional signal phases require longer cycle lengths to accommodate all movements. This situation results in delay and queue spillback for the heaviest-demand movements in both the AM and PM peaks.
 - During the AM peak, the southbound Route 1 left turn movement sees queue spillback beyond the available storage, affecting the southbound mainline.
 - During the PM peak, heavy queues for the southbound through movement block access to the southbound left turn lane.
 - During the PM peak, the northbound left turn queue also spills out of its turn pocket and affects mainline through traffic.
- **Route 1 and 23rd Street S/S Clark Street intersection cluster**
 - Similar to the intersection cluster with S Clark Street and 20th Street S, the provision for serving movements along S Clark Street results in a long cycle length to accommodate the additional signal phases, creating significant delays and queueing for the heaviest-demand movements on Route 1 in both the AM and PM peaks.
 - During the AM peak, severe queueing is observed along the northbound Route 1 approach, which carries a heavy volume of more than 2,000 vph and sees delays of more than 210 s/veh (LOS F). This queueing spills back through the Route 233 interchange.
 - Also during the AM peak, eastbound 23rd Street S queues spill back to the intersection with S Eads Street, creating significant delays and queueing for the northbound and eastbound approaches at that intersection.
 - During the PM peak, the average queue for the heavy movement of vehicles travelling southbound on Route 1 extends beyond the left turn lanes and prevents left turning vehicles from being able to enter the turn pocket. At the same time, northbound Route 1 left turning vehicles experience an average delay of over 120 s/veh (LOS F) due to the northbound through queue on average spilling back and preventing left turning vehicles moving into the left turning pocket.

Existing Transit Infrastructure and Operations

- The study area is served by the Metrorail Blue and Yellow Lines, local bus services, and commuter bus services.
- The WMATA-operated Metroway service is a bus rapid transit (BRT) line that features weekday peak period bus-only lanes and stops along 18th Street S and Crystal Drive.
- The AM and PM peak hour bus service experiences delays at the major intersections described above; there are several bus routes turning onto and off of Route 1 at these intersections.

Existing Pedestrian Infrastructure and Operations

- The study area has an extensive sidewalk network in place, accommodating both sides of the roads with facilities along nearly all roadways. Crosswalks are provided at every signalized intersection for nearly all legs.
- Several locations in the Core Street Study Area require pedestrians to wait at a pedestrian refuge to safely cross both directions of traffic. Pedestrian refuge areas only have capacity to hold only a few pedestrians, and two-stage crossings increase pedestrian delay significantly.
- The greatest delays for pedestrians are experienced at the Route 1/20th Street S/S Clark Street intersection cluster and the Route 1/23rd Street S/S Clark Street intersection cluster.

Existing Bicycle Infrastructure and Operations

- On-street bike lanes are provided along eastbound 15th Street S (but not westbound) through the Route 1 interchange and are provided in both directions along 18th Street S, which passes under Route 1. Bike lanes are not currently provided along 20th Street S or 23rd Street S in the vicinity of Route 1.
- Bicycle accommodations are not provided along Route 1, which is a limited access freeway north of 20th Street S.
- Within the core study area, cross street segments were assigned a Bicycle Level of Traffic Stress (BLTS) score of 2 or 3. Most of the segments scoring a BLTS 3 were due to the mixed traffic facilities where bicyclists share the road with traffic.
- Bicycle delay and travel times directly corresponded with the vehicular traffic operations. Most delays are experienced along 15th Street S at the interchange ramps with Route 1.

Existing Safety Issues

- The number of crashes occurring each year in the study has generally decreased over the past five years. About a third of the crashes have resulted in injuries, with the rest being property damage only (PDO). There were no fatalities during the study period.
- Most of the crashes occurred at signalized intersections, especially the 20th and 23rd Street S intersections. Seven crashes involving pedestrians or bicyclists occurred at the 23rd Street S intersection.
- Outside of the immediate vicinity of signalized intersections, the southbound Route 1 mainline had significantly more crashes than the northbound mainline by almost 20 crashes.
- The northbound Route 1 mainline experiences majority of its crashes near the I-395 interchange ramp area due to the weave between the on-ramp from 15th Street S and the off-ramps to Route 110 and I-395.
- The southbound Route 1 mainline experiences the majority of its crashes near Route 233 and between 12th Street S and 15th Street S. The Route 233 interchange has closely spaced diverge and merge points, while the Route 1 segment between 12th and 15th Street has a weave segment.

Existing Urban Form

- While there have been enhancements made to the built, natural, visual, and social environments in the Route 1 corridor in recent years, the majority of development faces away from Route 1.



Route 1 Multimodal Improvements Study

Appendix

November 2020



Appendix A

Framework Document



DRAFT November 18, 2020

Route 1 Multimodal Improvements Draft Framework Document

1. Introduction

This framework document defines the methodology and assumptions that will be used in the multimodal transportation analysis and concept design efforts for the **Route 1 Multimodal Improvements Project** in the Crystal City and Pentagon City neighborhoods of Arlington County. It provides assumptions and proposed methodologies relating to multimodal data collection, development of future traffic volumes, traffic operations and safety analyses, and design criteria.

1.1. PROJECT BACKGROUND

US Route 1/Richmond Highway (Route 1) is a major north/south primary arterial roadway linking Washington DC, Arlington County, the City of Alexandria, and southern suburbs including Fairfax County and Prince William County. Within Arlington County, Route 1 serves a variety of travelers, including those who use the road as a regional highway to access Washington DC to the north or the City of Alexandria and Fairfax County to the south and those who use the road for access to destinations in Crystal City and Pentagon City including Washington National Airport.

For the past 10 years, the evolution of Crystal City into a more multimodal area has been guided by Arlington County's Crystal City Sector Plan and its accompanying Crystal City Multimodal Transportation Study. Route 1 is a key component of the sector plan and the study. The long-term objective for Route 1 is to remove what is perceived as an east-west barrier within Crystal City and convert the highway portion of this road to an urban boulevard. Such a conversion would result in wide sidewalks, landscaped buffers with street trees, and an appropriate number of travel lanes to serve vehicles and transit. Converting Route 1 to an urban boulevard also would provide the opportunity for adjacent buildings to front the streets—for redevelopment projects to embrace Route 1 at their front door.

As a result of the integrated land use and transportation planning, Crystal City and Pentagon City have attracted major new development projects, especially the establishment of Amazon's second headquarters (HQ2), which will bring 25,000 jobs or more to these areas, and which is leading many other landowners to redevelop their properties. The November 2018 memorandum of understanding between Amazon and the Commonwealth of Virginia includes a commitment by the Commonwealth to implement transportation projects, including "mutually agreed upon improvements to Route 1." With this commitment, the Virginia Department of Transportation (VDOT) is taking the lead to develop and analyze the appropriate solutions for converting Route 1 to a multimodal, urban boulevard.

The National Landing Business Improvement District (BID) has been actively supporting these land use changes. In addition to growing its membership to include developments in Pentagon City and Potomac Yard, the BID recently published its "Area-Wide Strategic Plan" through its "Future Cities" project. One of the major initiatives of the plan is to transform Route 1, "unifying east and west by transforming Route 1 into an urban boulevard." The BID's plan states that "Transforming the roadway into a multi-modal, pedestrian-friendly, and urban-oriented boulevard presents the largest and most comprehensive opportunity to create a truly walkable, connected, urban downtown."



With the Commonwealth's commitment to improve Route 1—supported by the planning efforts of Arlington County and the National Landing BID —VDOT is moving forward with the necessary transportation analysis and engineering study to make the best decision possible on a future Route 1 in Crystal City. This study on Route 1, from approximately 12th Street S to 23rd Street S, will explore an at-grade urban boulevard, but also review and compare potential improvements to the current elevated condition, and the elevated urban boulevard described in the Crystal City Sector Plan.

1.2. PROJECT PURPOSE AND NEED

The purpose of the project is to improve multimodal connectivity and accommodations along and across Route 1 in Crystal City to meet the changing transportation needs of this growing urban activity center. The creation of an additional Amazon US Headquarters (HQ2) and other on-going development in the Crystal City/Pentagon City area is expected to increase multimodal transportation demand in an already heavily developed area with limited space for expanding the footprint of the transportation network. With increasing commercial and residential densities, there is a need to increase safety for all users including pedestrians, bicyclists, transit riders, and motorists, while also improving multimodal accessibility throughout Crystal City/Pentagon City, particularly to transit stations. Increased multimodal accessibility will improve person throughput for the corridor, which should also improve the pedestrian and bicycle experience crossing Route 1.

2. Multimodal Transportation Analysis Framework

2.1. MULTIMODAL TRANSPORTATION STUDY AREA

The multimodal transportation study project study area, as shown in **Figure 1**, includes Route 1 between the I-395/VA-110 interchange and the Washington National Airport/VA-233 interchange, inclusive of all interchanges and intersections along Route 1. It also includes the parallel north-south Arlington County streets of Fern Street, Eads Street, and Crystal Drive, as well as the overlapping east-west Arlington County streets of 12th Street, 15th Street, 18th Street, 20th Street, and 23rd Street. All signalized intersections and interchanges among these facilities are included in the study area. The study area also includes a selection of midblock driveways as included in the Arlington County Vissim model, described in **Section 2.6**.

The following interchanges are included in the project study area:

- Route 1/I-395/VA-110 – note that only the following south-facing ramps are included:
 - Southbound I-395 to southbound Route 1
 - Northbound Route 1 to northbound I-395
 - Southbound VA-110 to northbound I-395
 - Southbound VA-110 to southbound Route 1
 - Northbound Route 1 to northbound VA-110
- Route 1/15th Street
- Route 1/VA-233 (Washington National Airport access)
- The ramp from westbound VA-233 to northbound Crystal Drive

The following intersections are included in the project study area (see **Figure 1**):



DRAFT November 18, 2020

1. 12th Street/Fern Street
2. 12th Street/Eads Street
3. 12th Street/Army Navy Drive
4. 12th Street/Long Bridge Drive/Clark Street
5. 15th Street/Fern Street
6. 15th Street/Eads Street
7. 15th Street/Route 1 southbound ramps
8. 15th Street/Route 1 northbound ramps
9. 15th Street/Bell Street
10. 15th Street/14th Road S (Clark Street)
11. 15th Street/Crystal Drive
12. 18th Street/Fern Street
13. 18th Street/Eads Street
14. 18th Street/Bell Street
15. 18th Street/Crystal Drive
16. 20th Street/Eads Street
17. 20th Street/Route 1/Clark Street
18. 20th Street/Bell Street
19. 20th Street/Crystal Drive
20. 23rd Street/Fern Street
21. 23rd Street/Eads Street
22. 23rd Street/Route 1/Clark Street
23. 23rd Street/Crystal Drive



Figure 1: Project Study Area



2.2. TRAFFIC/MULTIMODAL DATA COLLECTION

The Kimley-Horn team will largely utilize existing available data sources, especially from Arlington County, to facilitate the multimodal transportation analysis. Separate from this Route 1 study, Arlington County has been conducting a Pentagon City Phased Development Site Plan (PDSP) study to evaluate future land use scenarios in the area. Specifically, for traffic operations analysis, Arlington County has developed Visum models and calibrated Vissim models that encompass nearly the entire project study area and contain existing peak period traffic volumes and signal timings. As described in **Section 2.6**, the Route 1 project Vissim model will be trimmed from the County's model and modified to fit within the limits of the project study area. This modified Route 1 model will utilize much of the available data already contained within the larger County PDSP Vissim model.

VDOT will provide copies to the Kimley-Horn team of previous studies/analyses and related project documentation such as development plans, traffic counts, crash data, utility information, right-of-way information, and the location survey, as well as the Vissim model provided by Arlington County. Where gaps exist in data or documentation, the Kimley-Horn team will work with VDOT and other stakeholders to obtain the necessary information. Arlington County's Existing Conditions Vissim Model Validation and Calibration Summary is provided as **Attachment 1** to this document.

A **Data Collection Memorandum** will be provided to VDOT summarizing the materials documented in the following sections.

2.2.1. Multimodal Traffic Volumes

Vehicular Traffic Volumes

Vehicular traffic volumes, including peak-hour turning movement and freeway mainline/ramp volumes, have been provided by Arlington County and are reflected in the County's Vissim model. The County traffic data includes truck percentages. The only locations in which traffic counts are not available are for the ramps at the I-395/Route 1 interchange; these ramp volumes will be derived using VDOT's StreetLight Data account by obtaining volume proportions and applying these proportions to the known balanced counts along Route 1 just south of the interchange.

Pedestrian Data

Pedestrian counts at all study area intersections and crosswalks are provided by Arlington County and reflected in the County's Vissim model.

Bicycle Data

Bicycle counts at all study area intersections have been provided by Arlington County from available count data from October 2019. The County did not collect bicycle count data for the PDSP study given the large size of the study area, and thus bicycles are not included in the PDSP study Vissim models. The Kimley-Horn team plans on incorporating bicycle volumes into the Route 1 study Vissim model, as described in **Section 2.6**.

Transit Data

Bus transit service through the study area, including service provided by WMATA (Metrobus), Arlington County (ART), Fairfax County (Fairfax Connector), PRTC (OmniRide), and Loudoun County Transit, are included within Arlington County's Vissim model. This includes modeling of all bus headways and dwell



times, as well as transit signal priority at relevant intersections, including those along the Crystal City-Potomac Yard Transitway along Crystal Drive. The Kimley-Horn team will assume consistent transit modeling in Vissim with the Arlington County model.

2.2.2. Traffic Signal Timings

Traffic signal timings will be provided via Arlington County's Synchro files for all intersections in the study area. Timings are also provided in the County's Vissim files. These are assumed to include the most up-to-date signal timing, phasing, and offset parameters; Arlington County staff have confirmed this as of September 2020.

2.2.3. Traffic Conditions Data

Speeds and Travel Times

Arlington County has provided historical INRIX speed and travel time data within the study area during the AM and PM Peak period for the Route 1 corridor. Arlington County has also provided field travel time run data for the following routes:

- Northbound/southbound Eads Street between 12th Street and 23rd Street
- Northbound/southbound Crystal Drive between 12th Street and VA-233

Queueing Data

Queueing data will be obtained from the Arlington County PDSP Vissim models and memorandum. It is assumed that for the purposes of this project, queueing data for existing Vissim model calibration will be focused on the Route 1 mainline and any immediately adjacent intersection turning movements in which queue lengths exceed available storage.

2.2.4. Crash Data

VDOT and Arlington County will provide crash data for 5 years for crashes reported on study area roadways within the project limits. It is assumed that this crash data will contain information on crash type (e.g. rear-end, side-swipe), involvement of bicycles or pedestrians, and other factors such as weather, lighting, etc.

2.3. ANALYSIS SCENARIOS

All analysis scenarios will be evaluated during the weekday AM peak period and PM peak period. The analysis hours are assumed to be consistent with the hours analyzed in the Arlington County PDSP analysis.

The following is a summary of the analysis scenarios:

- Existing Conditions (2019)
- 2025 No-Build
- 2040 No-Build
- 2025 Build Alternative 1
- 2025 Build Alternative 2
- 2040 Build Alternative 1
- 2040 Build Alternative 2



Saturday Analysis Considerations

VDOT Traffic Engineering requested a consideration of analysis for a Saturday condition along the corridor given anecdotal field observations of the corridor. Based on this request, the Kimley-Horn team pulled INRIX travel time data for the Route 1 corridor for average weekdays (Tuesdays, Wednesdays, and Thursdays) and average Saturdays across 2019. The resulting end-to-end travel times are provided in **Figure 2**, with travel times for average weekdays in orange and Saturdays in green. As shown, in the northbound direction, the greatest travel times are in the northbound direction during the weekday AM peak period; northbound travel times are generally consistent throughout the day on Saturdays. The greatest travel times in the southbound direction are during the weekday PM peak period, with Saturday travel times being consistent with or lower than weekday travel times throughout the course of the day.

Given the trend of redevelopment of commercial space in the study area toward office, it is likely that the greatest increases in multimodal traffic in the future will be during the weekday peak periods. Based on these findings, as well as the lack of availability of historic count data from 2019 for Saturdays, the VDOT project manager does not recommend conducting a Saturday analysis.

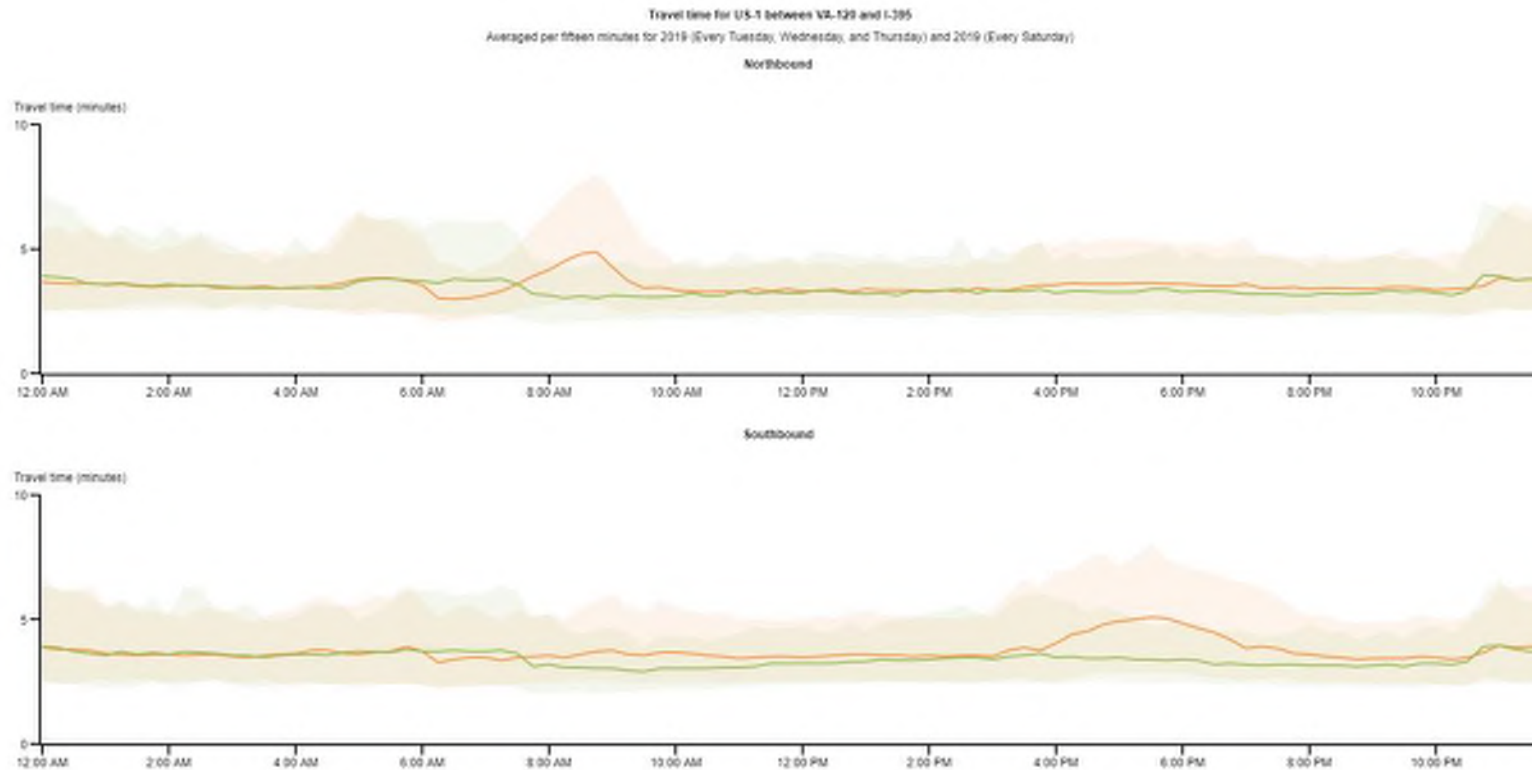


Figure 2: Route 1 INRIX Travel Time Comparison for Average Weekdays (Orange) and Average Saturdays (Green) in 2019

2.4. FUTURE BACKGROUND PROJECTS

Future No-Build and Build scenarios are assumed to include all background projects documented in the regional constrained long-range transportation plan (CLRP) to be complete by those analysis years. Within the project study area, this includes the Crystal City-Potomac Yard Transitway Northern Extension. The regional travel demand model, described in the next section, includes all projects in the CLRP as part of the model network, including other regional projects that affect travel through the study area. Arlington County also has several planned street reconfiguration projects (e.g. road diets, protected bike lanes) in the study area in their CIP that are not regionally significant enough to be documented in the CLRP but affect traffic operations in the study area. These projects are included in the County PDSP future scenario Vissim models and will be included in the Route 1 future scenario Vissim models for consistency.

2.5. TRAVEL DEMAND FORECASTING

Future multimodal travel demand is being forecasted using the MWCOG travel demand model and a post-processing methodology using Visum to refine traffic flows within the study area. This is consistent with the Arlington County PDSP traffic forecasting methodology. Vehicular traffic forecasts from the PDSP study will be used within the study area for the Vissim and Synchro models. Non-auto (bicycle and pedestrian) forecasts will be developed separately utilizing existing bicycle and pedestrian counts and growing these proportionally to the total population and employment in the MWCOG zones in the Pentagon City and Crystal City areas.

2.5.1. Travel Demand Model Validation

The Arlington County existing conditions (2019) MWCOG model will be validated to reflect existing regional travel patterns, with modifications to the model carried forward into future analysis year scenarios. This model uses the MWCOG travel demand model version 2.3.78 based on the 3,722 traffic analysis zone (TAZ) system in conjunction with Round 9.1a Cooperative Forecasts (socioeconomic data) for the Existing (2019), 2025, and 2040 model years¹. The model has been strategically modified with specific alterations to improve the accuracy and reliability of forecasts for the study corridor, roadways connected to the corridor, and transit services in the vicinity of the corridor.

The validation targets will be based on guidance from the FHWA Transportation Model Improvement Program (TMIP) *Travel Model Validation and Reasonableness Checking Manual* and the Virginia *Travel Demand Modeling Policies and Procedures Manual* (VTM). Because the MWCOG/TPB Model is already subject to scrutiny as a regional model which has been a subject of FHWA's TMIP Peer Review process, the validation process will focus on the "fit" to the project study area and will include a regional comparison to VDOT AADTs at the daily level using percent difference in total volume for cutlines. **Table 1** provides a listing of travel demand model validation criteria and thresholds for cutlines.

¹ Future-year forecasts will be updated within Arlington County to reflect the latest projections from the County Community Planning, Housing, and Development (CPHD) department, consistent with the County PDSP modeling process.

Table 1: Travel Demand Model Validation Criteria

Validation Scale	Validation Check		
Regional	% Difference in Total Volume for Cutlines	Cutline Volume	Threshold
		50,000	10%
		100,000	10%
		150,000	8%
		200,000	7%
		250,000	6%

The following cutlines, shown in **Figure 2**, will be used in the validation process:

- Cutline #1 (Washington, DC, bridge crossings)
 - I-66 (Roosevelt Bridge)
 - Memorial Bridge
 - US 1/I-395 (14th Street Bridge)
- Cutline #2 (north/south travel north of I-395)
 - George Washington Memorial Parkway north of I-395
 - VA-110 north of I-395
 - VA-27 (Washington Boulevard) north of VA-244 (Columbia Pike)
- Cutline #3 (north/south travel south/east of I-395)
 - George Washington Memorial Parkway south of I-395
 - Route 1 south of I-395 and north of 12th Street
 - Long Bridge Drive south of I-395 and north of 12th Street
 - Army Navy Drive south of I-395 and north of 12th Street
 - Eads Street south of I-395 and north of 12th Street
 - Fern Street south of I-395 and north of 12th Street
 - Hayes Street south of I-395 and north of 12th Street
 - Joyce Street south of I-395 and north of 12th Street
 - Arlington Ridge Road west of Joyce Street
 - Army Navy Drive west of Arlington Ridge Road
 - I-395 between Glebe Road and Washington Boulevard
- Cutline #4 (east/west travel west of study area)
 - Columbia Pike between Washington Boulevard east and west legs
 - I-395 within Washington Boulevard east and west legs
 - Arlington Ridge Road west of Joyce Street
 - 23rd Street east of Arlington Ridge Road
 - Glebe Road east of Arlington Ridge Road
- Cutline #5 (north/south travel south of study area)



- George Washington Memorial Parkway crossing Four Mile Run
- Potomac Avenue crossing Four Mile Run
- Route 1 crossing Four Mile Run
- Mount Vernon Avenue crossing Four Mile Run
- Cutline #6 (north/south travel immediately within study area)
 - Route 1 between 20th Street and I-395
 - Crystal Drive between 26th Street and 12th Street
 - Eads Street between 18th Street and I-395
 - Fern Street between 18th Street and I-395
 - Hayes Street between 15th Street and I-395

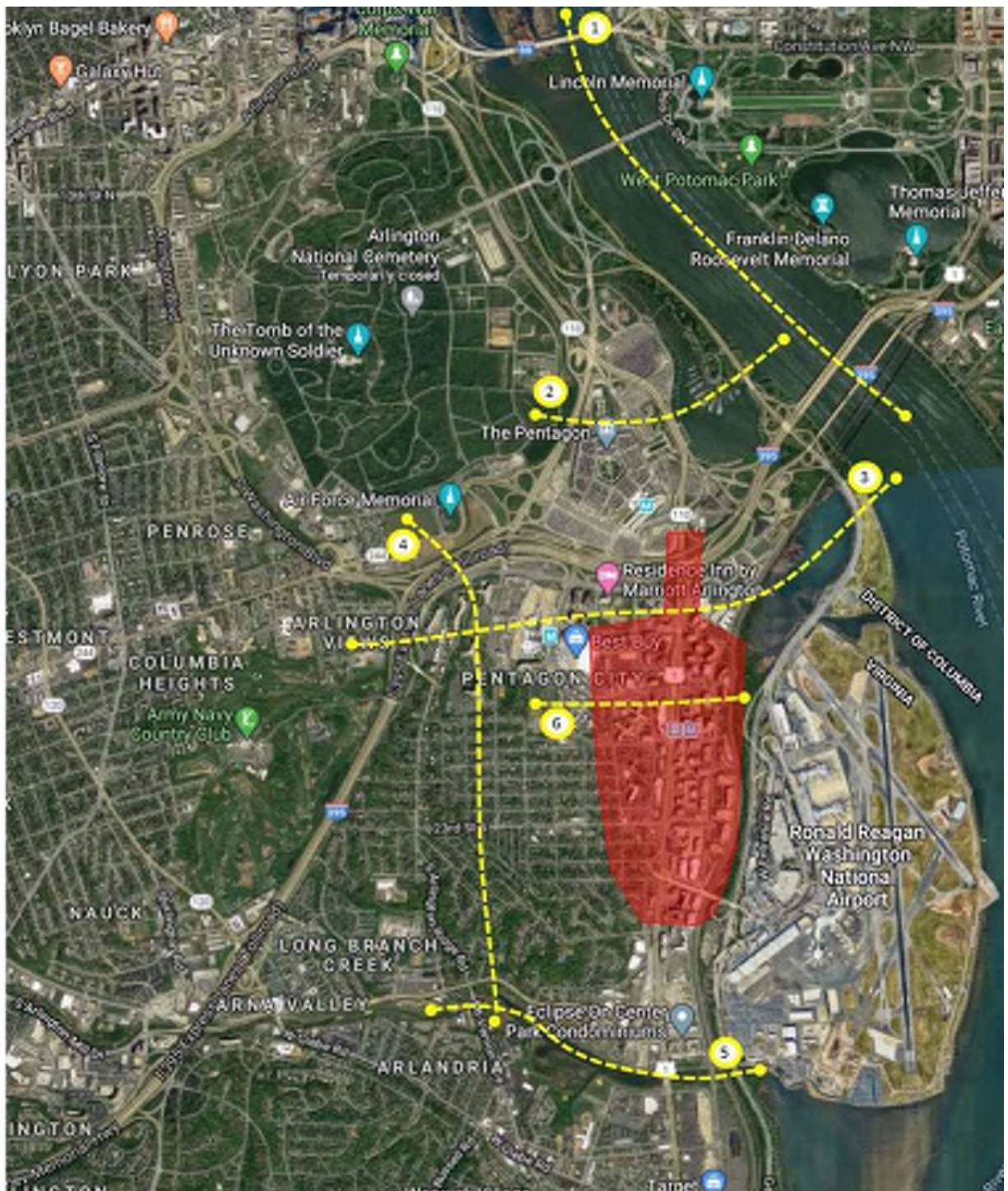


Figure 3: Proposed Cutlines for Travel Demand Model Validation



In addition to a comparison of modeled traffic volumes against field data, the trip distribution from the MWCOG model will be compared against mobile device O-D data from StreetLight. Trip distribution will be focused on trips into and out of the Pentagon City and Crystal City TAZs, with trips summarized by jurisdiction for the MWCOG model and StreetLight.

Visum Subarea Model

The Arlington County PDSP study uses a Visum subarea model to assign vehicular trips within the study area. The output trip tables from the MWCOG model will be disaggregated, adjusted, and brought into Visum models for the study area, consistent with the Arlington County PDSP process.

2.5.2. Future Analysis Scenario Assumptions

Future 2025 and 2040 No-Build vehicular traffic forecasts will use the Arlington County PDSP volumes in accordance with the County's forecasting methodology.

All relevant modifications made to existing conditions travel demand model during the validation process were carried forward to future analysis year scenarios. The MWCOG model was run for 2025 and 2040 No-Build analysis years. The travel demand model No-Build networks included all roadway and transit projects in the most up-to-date regional CLRP and updated socioeconomic data forecasts within Arlington County. These forecasts have been updated to reflect the latest projections from the County Community Planning, Housing, and Development (CPHD) department. The output trip tables from the MWCOG model have been disaggregated, adjusted, and brought into Visum models for the study area and then assigned to the study area network, resulting in peak-hour vehicular traffic volumes.

It is assumed that the same future forecast volumes will be used for the No-Build and Build scenarios for the same analysis years; these volumes may will be redistributed within the network for the Build scenario based on the proposed geometric changes.

The Kimley-Horn team will coordinate with VDOT, Arlington County, and Arlington County's consultant team throughout this process to ensure consistency with travel demand modeling approaches and future traffic volume forecasting.

Forecasts for non-vehicular modes (bicycles and pedestrians) will also be developed utilizing existing bicycle and pedestrian counts and growing these proportionally to the total population and employment in the MWCOG zones in the Pentagon City and Crystal City areas.

2.6. TRAFFIC OPERATIONS ANALYSIS

2.6.1. Traffic Analysis Tools

Vissim Version 11.0 (consistent with Arlington County's Vissim model) will be used for the traffic analysis performed within the study area limits, with the exceptions of the intersections along Fern Street, which will be analyzed using Synchro 10. Use of these tools is consistent with the VDOT *Traffic Operations and Safety Analysis Manual 2.0* (TOSAM)² updated in February 2020.

² <http://www.virginiadot.org/business/resources/TOSAM.pdf>

Synchro will also be utilized to develop preliminary optimization for phasing and signal timing for future-year scenarios to be carried forward into Vissim models as well as screening of preliminary concepts prior to the development of the two Build Alternatives.

2.6.2. Vissim Model Development

The Kimley-Horn team will update the Vissim model developed by Arlington County by trimming to include only study area intersections and roadway segments (with the exception of Fern Street). The team has coordinated with Arlington County and confirmed that the Vissim model contains up-to-date intersection geometry, traffic signal timings, and transit routes and stops. The team will add the ramps at the Route 1/I-395 interchange noted in **Section 2.1** to the Vissim network.

Within the immediate vicinity of Route 1 (intersections and interchanges), the Kimley-Horn team will add bicycle facilities to the network and incorporate bicycle volumes from the Arlington County Count data.

2.6.3. Measures of Effectiveness

Table 2 lists proposed measures of effectiveness (MOEs) to be used for operational analysis of the roadway network under existing and future No-Build and Build conditions. Wherever possible, MOEs will be provided in graphical format or GIS maps.

Table 2: Multimodal Traffic Operations Analysis Measures of Effectiveness

Mode	Measure of Effectiveness	Source ³
Vehicle	Intersection Delay ⁴	Vissim
	Intersection HCM-Analogous Level of Service (LOS) ⁵	Vissim
	Intersection Approach Queue Length (Average and Maximum)	Vissim
	Travel Times along Key Routes	Vissim
Transit	Intersection Delay ⁶	Vissim
	Travel Times along Key Routes	Vissim
	Average Network Speeds (Network-Wide)	Vissim
Pedestrian	Intersection Delay ⁶	Vissim
	Crossing Times ⁶	Calculated based on crossing distance for each concept
	Pedestrian Experience and Comfort	Area of sidewalk in the public right-of-way
	Quantity of Enhanced Crosswalks	Number of new or enhanced pedestrian crossings provided
Bicycle	Intersection Delay ⁶	Vissim
	Travel Times along Key Routes	Vissim

³ MOEs for intersections along Fern Street will be reported using Synchro and will apply to vehicular traffic only.

⁴ Microsimulation delay, not HCM delay except for Fern Street intersections which will be HCM.

⁵ LOS is used solely to communicate results and is not equivalent to LOS as determined using the HCM.

⁶ Intersection-level metrics for transit, bicycles, and pedestrians will be produced only for the intersections along Route 1 and immediately adjacent to Route 1 (e.g. intersections with interchange ramps).

Mode	Measure of Effectiveness	Source ³
	Bicycle Level of Traffic Stress ⁶	GIS, using available geometric and traffic data

2.6.4. Vissim Model Calibration

The Arlington County Vissim model has been refined and calibrated using guidance from the TOSAM v.2 as well as FHWA; while the model has not been reviewed by VDOT, the County has approved of the calibration process, which is documented in a memorandum and provided as **Attachment 1**. For the Route 1 study, the Kimley-Horn team will debug and “re-calibrate” the existing conditions for the AM and PM Vissim models after trimming the County model to only contain the project study area. The purpose of this updated calibration is only to ensure that the trimmed Vissim model for the Route 1 study area is still in alignment with the previous calibration and with VDOT guidelines. Calibration thresholds for each measure are summarized in **Table 3** and discussed below.

Table 3: Vissim Calibration Criteria and Acceptance Targets⁷

Calibration Item	Basis	Criteria	Target
Simulated Traffic Volume (vph)	By Intersection Approach	Within ± 20% for <100 vph	At least 85% of all Intersection Approaches
		Within ± 15% for ≥ 100 vph to < 1000 vph	
		Within ± 10% for ≥ 1000 vph to < 5,000 vph	
		Within ± 500 vph for ≥ 5,000 vph	
Simulated Traffic Volume (vph)	By Freeway/Ramp Segments	Within ± 20% for <100 vph	At least 85% of all Freeway Segments
		Within ± 15% for ≥ 100 vph to < 1000 vph	
		Within ± 10% for ≥ 1000 vph to < 5,000 vph	
		Within ± 500 vph for ≥ 5,000 vph	
Simulated Travel Time (s)	By Route	Within ± 30% for average travel times on arterials	At least 85% of all Travel Time Routes
Simulated Queue Length (ft)	By Approach for Targeted Critical Locations	Visually acceptable maximum queue lengths are represented at critical locations.	Qualitative Visual Match compared to the Arlington County Vissim Model or field queue data from County

⁷ Calibration criteria from TOSAM 2.0 <http://www.virginiadot.org/business/resources/TOSAM.pdf>

1. **Traffic Volume:** Simulated throughput will be calibrated using field data collected during the AM and PM peak hours. Intersection traffic volumes will be calibrated by approach at the study intersections. Freeway traffic volumes will be calibrated for mainline and ramp segments.
2. **Travel Time:** Simulated travel time will be calibrated using field data collected during the AM and PM peak periods. Where field travel times are not available, outputs from the Route 1 Vissim models will be compared against outputs from the larger Arlington County models.
3. **Queue Length:** Simulated queues will be calibrated using a visual review against the ongoing Arlington County study to ensure that queue lengths are represented at critical locations. The key queue locations will be based on the County's Vissim model calibration documentation, including locations along Route 1, Eads Street, and Crystal Drive. The targeted locations for queue calibration are as follows:
 - AM Peak Period
 - Northbound Route 1 approaching 20th Street and 23rd Street
 - Eastbound 15th Street approaching Route 1, including eastbound left-turn to on-ramp to northbound Route 1
 - Eastbound 23rd Street approaching Route 1 interchange
 - Northbound Route 1 approaching I-395 interchange
 - Southbound Army Navy Drive approaching 12th Street
 - PM Peak Period
 - Southbound Route 1 approaching 20th Street
 - Southbound Route 1 off-ramp to 15th Street
 - Westbound 23rd Street approaching Route 1
 - Northbound Route 1 approaching 23rd Street
 - Eads Street
 - Northbound Crystal Drive approaching 15th Street
 - Southbound Crystal Drive approaching 23rd Street

2.6.5. Simulation Time, Seeding Time, and Number of Runs

A 3-hour simulation period will be used, consistent with the Arlington County PDSP model. This includes a 1-hour warm-up period, 1-hour peak, and 1-hour shoulder period. The required sample size (i.e., number of model simulation runs) will be determined based on TOSAM guidance and the VDOT Sample Size Determination Tool.

2.6.6. Future Build Scenario Traffic Operations Analysis

For future Build scenarios, Section 3 provides an overview of concept development. It is assumed that an initial screening process to test concepts will be conducted using Synchro in advance of modeling two Build alternatives (noted above) using Vissim.

2.7. SAFETY ANALYSIS

2.7.1. Existing Crash and Geometry Review

Using crash data provided by VDOT/Arlington County, the Kimley-Horn team will summarize the crash history for the intersections along Route 1 and immediately adjacent to Route 1 (e.g. intersections at



grade-separated interchanges). Project area and intersection crash data will be summarized in tabular format for up to five pertinent assumed crash causes, such as weather conditions, lighting conditions, type of collision, and severity of crash, as necessary, to aid in identifying crash patterns. The Kimley-Horn team will develop a graphic using GIS to illustrate the location, crash type, and crash severity of study area crashes. Also, for safety comparison purposes, the team will compare findings to crash rates along Route 1 to similar urban facilities in Virginia, based on the Statewide database for similar facility crash rates. A breakdown of crashes involving bicycles, pedestrians, and transit will be included.

The Kimley-Horn team will review existing geometry data and design exception and design waiver information and identify any geometric deficiencies based on VDOT and AASHTO requirements.

2.7.2. Future Conditions Crash Prediction

The Kimley-Horn team will assess safety as part of the Build alternatives using the Highway Safety Manual methodologies and accounting for Crash Modification Factors (CMFs), where available, associated with various treatments proposed in the two Build alternatives. The resulting outputs will include predicted number of crashes, allowing for a quantitative comparison of intersection safety across the Build alternatives. A qualitative assessment of intersection safety based on findings from the Existing Conditions assessment as well as improvements proposed in the Build alternatives will also be included.

2.8. ADDITIONAL MULTIMODAL ANALYSES

2.8.1. Pedestrian Crossing Distance and Comfort

The Kimley-Horn team will review required versus provided pedestrian crossing times at all signalized intersections along Route 1 and immediately adjacent to Route 1 (e.g. existing signalized intersections at grade-separated interchanges), including an assessment of whether the provided time is sufficient. Pedestrian distance and crossing time will be evaluated and compared for No-Build and two Build alternatives.

In addition to pedestrian crossing time, the Kimley-Horn team will evaluate and compare pedestrian experience and comfort among the No-Build and two Build alternatives. This measure will be based on the area of sidewalk in the public right-of-way in the core street reconfiguration area. In addition, the Kimley-Horn team will measure the quantity of new or enhanced crosswalks provided by the two Build alternatives and the crossing distance.

2.8.2. Bicycle Level of Traffic Stress (LTS)

The Kimley-Horn team will assess Bicycle Level of Traffic Stress (LTS) using the methodology developed by the Mineta Transportation Institute in 2012⁸ considering different street elements. Bicycle LTS is scored from one to four (one representing low stress for a bicyclist and four representing high stress for a bicyclist), based on factors such as bicycle facility type, traffic speed, street width, and bike lane width. The combination of these factors contributes to the level of stress that a bicyclist may feel as they travel

⁸ <https://transweb.sjsu.edu/research/low-stress-bicycling-and-network-connectivity>



along a roadway segment. A street with a BLTS score of one provides comfortable and a low stress riding experience for bicyclists of all ages and abilities.

BLTS can be assigned for segments, pocket lanes on intersection approaches, and crossings (unsignalized intersections). Mineta has developed criteria that assign BLTS for each element based on a series of classification tables. Visual inspection of the street (either in person or via satellite mapping) is required to assign a classification.

The Kimley-Horn team will evaluate existing BLTS for the east-west roadways intersecting the Route 1 corridor, as well as BLTS for No-Build and Build alternatives.

3. Build Concept Development Design Framework

3.1. CONCEPT DESIGN AREA

The multimodal concept design area, as shown in **Figure 3**, consists of Route 1 from 12th St. S on the north to 23rd St. S on the south and includes the intersections of Route 1 with 15th St. S, 18th St. S., and 20th St. S.



Figure 4: Concept Design Area

3.2. CONCEPTS

The Kimley-Horn team will develop concepts for the design area in coordination with the traffic analysis. The following concepts will be developed using Bentley's OpenRoads ConceptStation:

- Route 1 at-grade alignment (2 options)
 - Vertical alignment adjusted to create an urban boulevard
 - 15th St. S interchange modified to be an at-grade intersection
 - 18th St. S underpass modified to be an at-grade intersection



- 20th St. S intersection reconfigured east and west
- 12th St. S and 23rd St. S no changes, but included for concept connection

The Crystal City Sector Plan concept will be reviewed qualitatively (high level) for comparison to the existing conditions and No-Build. However, no multimodal transportation analysis or concept development will be performed for the Sector Plan concept.

The VDOT Road Design Manual, Arlington County Construction Standards, AASHTO Green Book, and NACTO Guidelines will be used by the Kimley-Horn team in the development of the typical sections and the horizontal and vertical alignment. The concepts will be developed under the assumption VDOT will retain maintenance responsibilities of the Route 1 corridor and the immediate vicinity of the intersections with Route 1. Arlington County will retain maintenance responsibilities of the side streets along Route 1. The design standards of VDOT and Arlington County will be applied as applicable to the concepts. **Table 4** outlines the initial design assumptions.

Table 4: Design Assumptions

Item	Route 1	15 th St. S	18 St. S	20 th St. S
VDOT Road Classification	GS-5	GS-6	GS-6	GS-7
Arlington County Classification	Type F	Type A	Type A	Type A
Design Vehicle	CITY-BUS	CITY-BUS	CITY-BUS	CITY-BUS
Control Vehicle	WB-67	WB-67	WB-67	WB-67
Posted Speed	35 MPH	25 MPH	25 MPH	Not Posted
Design Speed	35 MPH	25 MPH	25 MPH	25 MPH
Travel Lane Width	11' - 12'	11'	11'	11'
Number of Travel Lanes	6	4	4	2
Sidewalk Width	6' – 10'	10' – 16'	10' – 16'	10' – 16'
Bike Facility	Adjacent Road	Bike Lanes	Bike Lanes	Shared Lanes
Median Style	Landscaped or Concrete	None	None	None
Parking Style	None	Both Sides – 8'	Both Sides – 8'	Both Sides – 8'
Minimum Effective Radius*	25'	25'	25'	25'
Minimum Curb Radius*	15'	15'	15'	15'

*Minimum radii are based on demonstration that the design vehicle can make the turn without encroaching into opposing traffic.

3.2.1. Concept Screening

The initial screening of the intersection and alignment concepts will be conducted in coordination with the traffic analysis using the Measures of Effectiveness (MOEs) described in Section 2.6.3 of this framework document. Further screening and refinement of the concepts will be conducted after incorporating feedback from VDOT, the Task Force, and other community input. Ultimately, the final screening of the



concepts will be developed using the technical analysis, input from Task Force, and input from the public and will be agreed on by VDOT.

3.2.2. Concept Evaluation

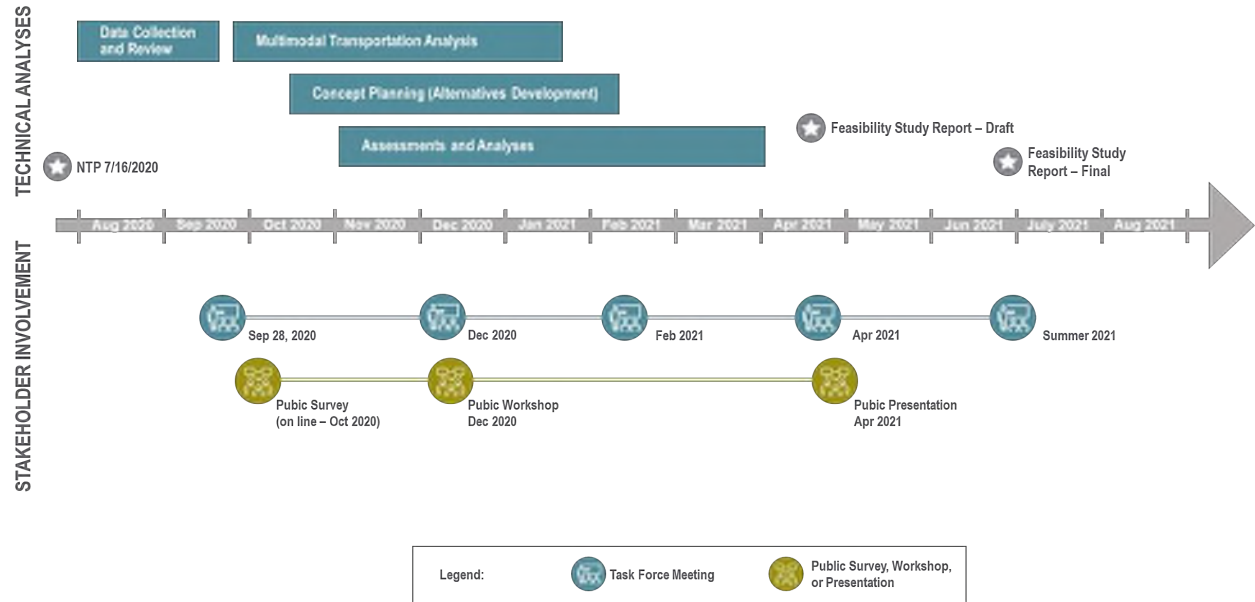
The concepts will be evaluated as outlined below. The following items will be included in the evaluation of the two concepts.

- Multimodal transportation analysis and operations
- Safety
- Right-of-way and overall corridor layout
- Sequence of construction to demonstrate constructability and impacts during construction including evaluation of existing structures
- Multimodal and Redevelopment Potential Memorandum to analyze mobility and future accommodations of development along the corridor
- Stormwater Management to compare the strategies to meet water quantity and water quality requirements
- Cost Estimate to evaluate overall project costs and document assumptions, as well as develop a risk matrix to support VDOT's determination of contingency

These technical memorandums and exhibits, along with the traffic analysis, will be combined into the Feasibility Study Report. This document will evaluate the two concepts and present the findings of our research and analysis.

4. Project Milestones and Deliverables

Below is the anticipated schedule dependent upon scheduling availability for Task Force and public meetings as well as project deliverable review time.



Deliverables:

- Data Collection Memorandum
- Public Involvement Plan, Task Force and Public Meeting materials
- Existing Conditions Summary
- Traffic Forecasting Memorandum
- 2025 and 2040 No-Build Conditions Summary
- 2025 and 2040 Build Conditions Summary
- Draft and Final Study Report



Appendix B

Data Collection Summary



Data Collection Summary

This document summarizes data collected for the Route 1 Multimodal Improvements Study, including a tabulation of data requested and obtained from VDOT and external agencies. The Kimley-Horn team will largely utilize existing available data sources, especially from Arlington County, to facilitate the multimodal transportation analysis and concept design process. Separate from this Route 1 study, Arlington County has been conducting a Pentagon City Phased Development Site Plan (PDSP) study to evaluate future land use scenarios in the area. Much of the data obtained for the multimodal transportation analysis borrows from the PDSP study.

Table 1 provides a detailed listing of data requested at project kick-off and subsequent resolution of each requested element. *Note that there are some elements in which data requests are still outstanding; these elements are highlighted in yellow and will be updated as the project progresses and provided with the final report in 2021.*

Table 1. Data Requests and Resolutions

Data Requested:	Resolution:
a. VDOT annual average daily traffic (AADT) counts for Route 1 and streets within the study area for pre-COVID-19 traffic conditions	Obtained via VDOT count book; 24-hour counts for the Route 1/SR 233 interchange provided by Arlington County
b. Recent (pre-COVID-19) weekday AM and PM peak period traffic counts collected at signalized and unsignalized intersections in the study area	Raw count files provided for all intersections by Arlington County; spreadsheets provided with balanced volumes as well; raw count data includes bike counts.
c. Arlington County's Synchro files for these intersections (which should include the most recent signal timing, phasing, and offset parameters)	Obtained from Arlington County; RBCs in County Vissim model contain most up-to-date timings according to County staff.
d. Arlington County's traffic simulation (i.e., Vissim and Visum) files, assumed to contain the entire study area	Vissim and Visum files were obtained from Arlington County for Existing (2019) conditions. Corresponding No-Build 2025 and 2045 conditions will also be provided by Arlington County in late 2020 following internal County review.
e. I-395 traffic volume, travel time, and Vissim. data from the recent express lane improvements project	This data has been incorporated into Arlington County Vissim models and traffic analysis. One exception is interchange ramp volumes at the Route 1/I-395 and Route 1/SR 233 interchanges. For these locations, proportions were obtained via VDOT's StreetLight Data subscription and applied to downstream volumes to obtain peak-hour traffic volumes.
f. Crash data for 5 years for crashes reported on study area roadways within the project limits	Obtained via Virginia Roads (VDOT) online database.
g. Latest version of the MWCOC Travel Demand Model, including latest version of cooperative forecasts	Latest model version (v2.3.78) obtained by request from MWCOC. Arlington County provided their modified version of this model, which included network refinement and zone centroid connector refinements within the project study area.
h. Historical INRIX speed data within the study area during the AM and PM peak period	Obtained from Arlington County as part of County's PDSP Study Vissim Calibration Memo; includes travel times for Route 1, Crystal Drive, and Eads Street.
i. GIS mapping files and aerial imagery	Aerials have been obtained from VDOT.
j. Approved and unbuilt development information and plans for the proposed Amazon campus and other potential development in Pentagon City and Crystal City and including recent traffic studies and traffic impact analyses (TIAs)	Meeting held 9/3 with Arlington County staff to discuss; development map provided by County staff as well as links to online documentation of approved and unbuilt developments.
k. Arlington County Master Plan and its elements (e.g., Bike MTP, etc.)	Obtained via Arlington County website.
l. Crystal City Sector Plan, Crystal City Multimodal Transportation Study, Crystal City BID Area-Wide Strategic Plan	Obtained via Arlington County website.
m. Transit data and as-built info (e.g. Bus stops and routes, Metro, etc.)	Provided within Arlington County Vissim models - includes all stops and bus routes in study area.
n. Active and other traffic data (Bike Share, Car Share, etc.), including existing and planned bike routes	Bicycle and pedestrian counts provided by Arlington County.
o. Traffic Mode Share (mode share info from approved and unbuilt development)	Mode share will be derived from the traffic forecasts used in the Arlington County PDSP study.



Data Requested:	Resolution:
p. Proposed design concepts by others (including sketches, plans, CADD files, etc.)	<ul style="list-style-type: none"> • Crystal City Sector Plan concepts obtained via download from Arlington County website. • Potential reconfiguration concepts for Route 1/20th Street intersection provided by Arlington County (included as part of ongoing development traffic study). • Renderings of Route 1 cross-sections from National Landing BID study provided by Arlington County.
q. Survey data from VDOT (e.g. contour, topo, utilities, etc.)	Obtained via survey from VDOT.
r. Survey data/files from recent public and private projects	Obtained via survey from VDOT.
s. ROW and permit data (if not in survey)	Obtained via survey from VDOT.
t. ITS, lighting, and utility plans and related information	Obtained via survey from VDOT.
u. As-built plans (e.g. Structures, Metro Tunnel, Ped. Bridges) for Route 1 and cross streets	Obtained via survey from VDOT. For the Metrorail tunnel, the project team coordinated with WMATA 10/8 and followed up 10/19 (Jim Ashe and Benli Li). WMATA is conducting an impact evaluation and requires a signed NDA. WMATA as-builts as needed to understand depth of Metrorail tunnel.
v. Geotechnical information in the form of recent borings and previous investigations and reports	Provided by VDOT
w. Land use data (e.g., park facilities, open space, events, etc.)	Obtained via survey from VDOT. Need from Arlington if available
x. Approved VDOT design waiver and design exceptions from previous projects	No known waivers or exceptions at this time following coordination with VDOT (Tim Belcher) in September 2020.
y. Bridge inspection reports	Provided by VDOT
z. Load rating data for existing structures	Provided by VDOT



Appendix C

Vissim Model Validation and Calibration Summary



1. Introduction

This document summarizes the Existing Conditions (2019) Vissim calibration results for the **Route 1 Multimodal Improvements Project**. The procedures and assumptions herein follow the agreed-upon traffic analysis methodology documented in the project framework document (dated November 3, 2020). The Kimley-Horn team used existing available data sources to facilitate the multimodal transportation analysis. Separate from this project, Arlington County has been conducting a Pentagon City Phased Development Site Plan (PDSP) to evaluate future land use scenarios in the area. As part of this project, Arlington County calibrated Vissim and Synchro models that encompass nearly the entire Route 1 study area and contain existing peak period traffic volumes and signal timings. Existing models and previously collected traffic data were used to coordinate the two projects as well as overcome the challenges in data collection during the COVID-19 pandemic.

The Kimley-Horn team updated Arlington County's PDSP existing conditions AM and PM Vissim models by trimming the extents to match the defined Route 1 transportation analysis study area (with the exception of Fern Street, which is evaluated in Synchro 10). The team gathered information from Arlington County and confirmed that the Vissim model contained up-to-date intersection geometry, traffic signal timings, traffic demand, and transit routes and stops. The resulting Vissim models were reviewed for quality assurance and the following adjustments were made deviating from the Arlington County model:

- The study area was cut to reflect the Route 1 study extents. The north end of the network on Route 1 was extended to include the ramps entering and exiting I-395 from Route 1 and Route 110. On the southern end, ramps were added to represent travel demand to and from Route 233 (Washington National Airport Access Road).
 - In areas where the Arlington County model was extended to encompass the Route 1 study area, calibration adjustments were made to ensure realistic model performance.
- Dedicated bicycle facilities were added on relevant east-west streets crossing Route 1 (15th Street S and 18th Street S).
- Coding elements of the models were reviewed thoroughly and minor adjustments were made to lane geometry, driver yielding behavior, pedestrian and bicycle inputs and behavior, and intersection control.

Evidence of model calibration presented in this document was developed from a comparison against the original calibrated (non-trimmed) PDSP model as determined in the Framework Document. Travel time data could not be directly applied from the PDSP project because of the differences in study area extents; therefore, successful calibration of the PDSP model per the Virginia Department of Transportation (VDOT) *Traffic Operations and Safety Analysis Manual (TOSAM)* requirements was confirmed and the trimmed Route 1 models were calibrated using the PDSP model as the baseline. The PDSP Calibration Memorandum from Arlington County is provided in **Attachment 1 of the Framework Document**, which is included as **Appendix A to the Existing Conditions Report**. This document should be referenced for detailed model calibration procedures and assumptions maintained from the PDSP Vissim models.

The Synchro AM and PM models were updated to match the PDSP Vissim signal timings, which were confirmed by Arlington County to be the most up-to-date signal timings and are used to report Fern Street intersection measures of effectiveness (MOEs) within the study area. Synchro also will be used to develop preliminary optimization for phasing and signal timing for future-year scenarios to be carried forward into Vissim models as well as screening of preliminary concepts prior to the development of the two Build Alternatives.



1.1. TRAFFIC ANALYSIS CHARACTERISTICS

The Route 1 study area is shown in **Figure 1-1**. As denoted on the map, the intersections along Route 1, Eads Street, and Crystal Drive are included in the Vissim traffic analysis. The intersections on Fern Street (i.e., two streets west of Route 1) are exclusively evaluated in Synchro.

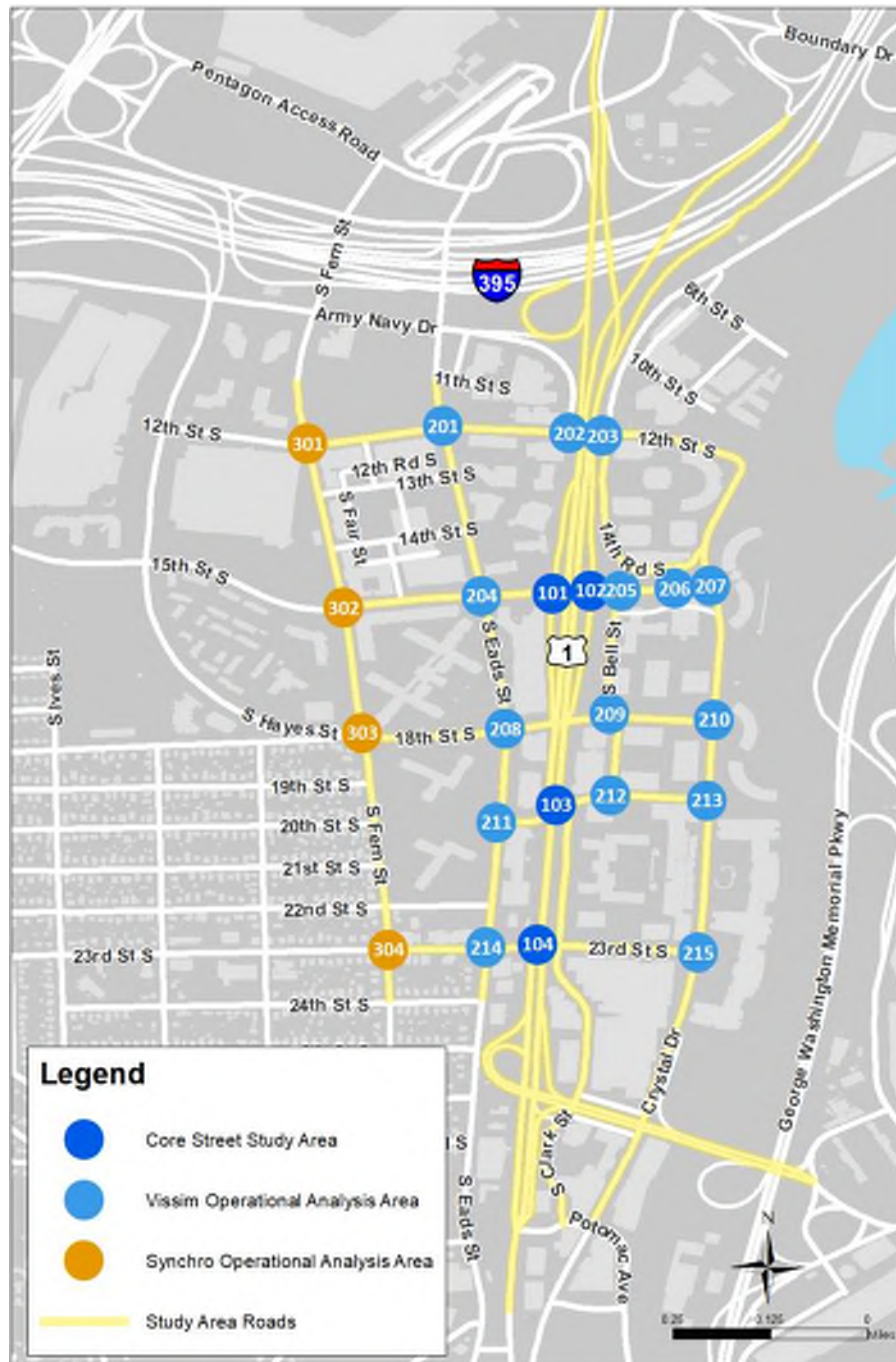


Figure 1-1: Transportation Analysis Study Area



2. Vissim Model Overview

2.1. NETWORK CODING ASSUMPTIONS

2.1.1. Roadway Geometry

As described in the Introduction, Vissim models developed as part of the Arlington County PDSP project were used as the baseline for model development. Lane configurations and geometries were confirmed using aerial imagery and survey data collected for the Route 1 project. Additional roadway elements not included in the PDSP model were added to reflect the full study area extents. These locations are outlined below.

- The north end of the network on Route 1 was extended to include the ramps entering and exiting I-395 from Route 1 and Route 110.
- On the southern end, ramps were added to represent travel demand to and from Route 233.

2.1.2. Travel Speed

Desired speed distributions—or model free-flow speeds—were set based on posted speed limits and the following guidance provided by TOSAM:

- Linear distribution representing 5 miles per hour (mph) above and below the posted speed limit for arterials and ramps.
- Linear distribution between 7.5 and 15.5 mph for right-turning movements at intersections.
- Linear distribution between 12.4 and 18.6 mph for left-turning movements at intersections.

2.1.3. Vehicular Traffic Demand

The following describes the input of vehicular traffic demand into the Route 1 Vissim models:

- Vehicular traffic volumes, including peak hour turning movement and ramp volumes, were provided by Arlington County and reflected in the County's Vissim model. Balanced peak hour volumes from Arlington County were used to develop vehicle inputs and adjust vehicle routes within the Route 1 study area.
- The “exact volume” arrival distribution was used for all vehicle inputs.
- “Relay routing” (via static routing decisions) was used in the model to route vehicles from origins to destinations. In locations with closely spaced intersections, routes were extended beyond a single intersection to ensure realistic lane use and driving behavior.
- A composition of 2 percent trucks is used throughout the network to model heavy vehicles, consistent with the PDSP study and with field traffic counts.
- Vehicular volumes were quality-checked to ensure the model routes and inputs match the balanced counts.

2.1.4. Bus Transit Service

Bus transit services located within the study area represented in Arlington County's PDSP model were carried through to the Route 1 study Vissim models. These transit service providers included the Washington Metropolitan Area Transit Authority (WMATA), Arlington Transit (ART), Fairfax Connector, Loudoun County Transit, and PRTC. A list of the public transportation lines represented in the models, including their service type and headways, is included within the **Existing Conditions Report**.

To service these designated routes, 38 bus stops were coded in the AM and PM Vissim models collectively.



Bus dwell times were carried over from the Arlington County PDSP model and reflect a normal distribution with an average of 45 seconds and a standard deviation of 5 seconds. This distribution was applied consistently throughout the model at all stops for all bus routes.

2.1.5. Pedestrian Demand

Pedestrian counts at all study area intersections and crosswalks were provided by Arlington County and reflected in the PDSP Vissim model. At locations in the network where pedestrian inputs were missing, additional October 2019 count data provided by Arlington County was used to supplement. In cases where the PDSP model did not include a pedestrian crosswalk and field data was unavailable, pedestrian demand was inferred from immediately adjacent intersections.

2.1.6. Bicycle Demand

The Arlington County PDSP model did not include bicycle facilities or inputs. The Route 1 study model was updated to introduce dedicated bicycle facilities located along crossing streets of the Route 1 corridor (15th Street S and 18th Street S). Bicycle demand volumes were determined from the additional count data provided by Arlington County.

2.1.7. Simulation Time

A 3-hour simulation period was selected to capture the onset and dissipation of study area congestion. This consisted of a 1-hour seeding period, 1-hour peak period, and 1-hour shoulder period. As described in the PDSP Calibration Memorandum, a representative peak hour was selected for the AM and PM peak periods and global factors were applied to the calculated peak hour volumes to generate seeding and dissipation volume demand. The time periods adapted from the PDSP model are shown in **Figure 2-1**.

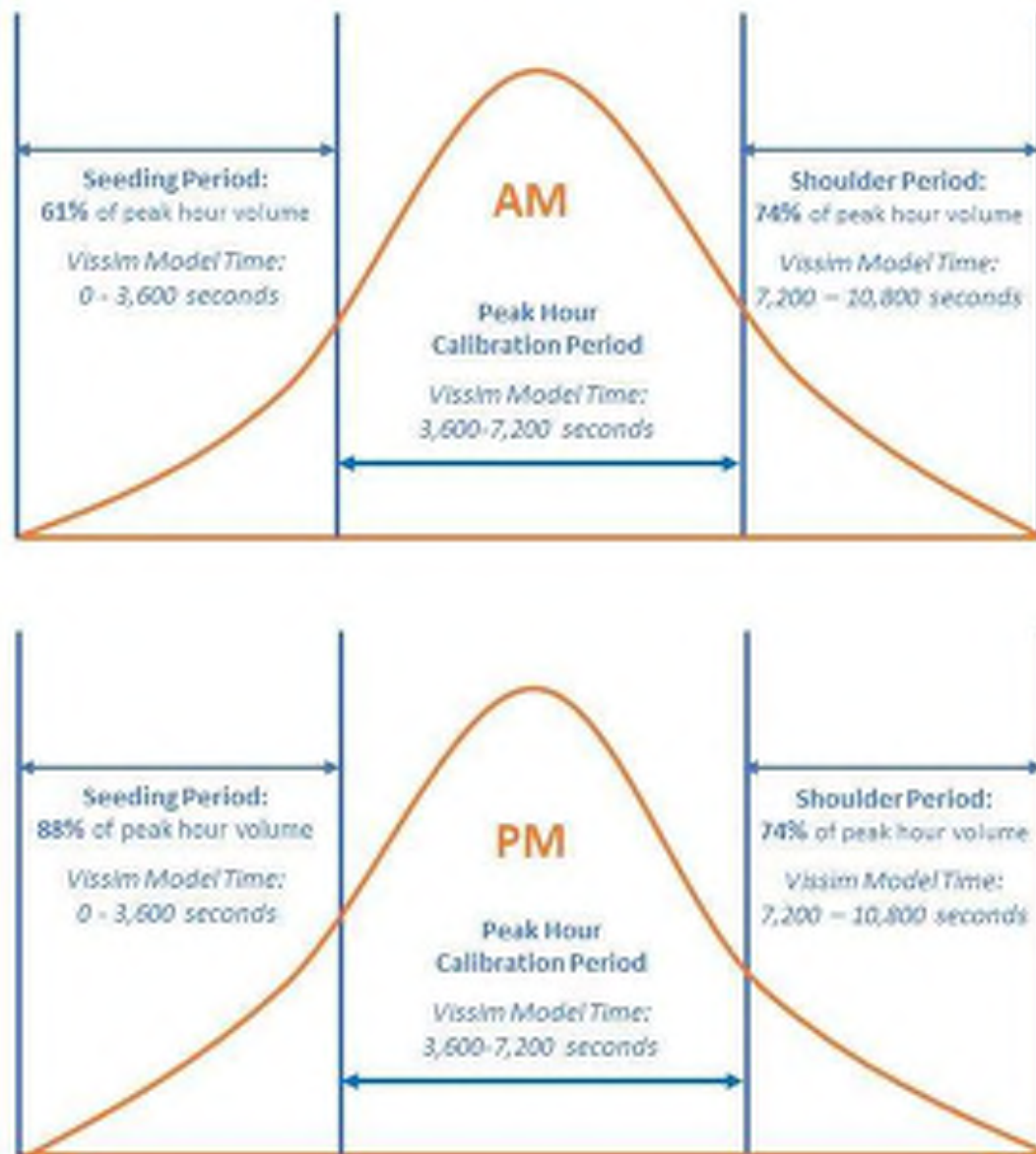


Figure 2-1: Vissim Simulation Time and Loading Assumptions

2.2. MODEL CALIBRATION

2.2.1. Background

The purpose of a simulation model is to investigate the impacts of the proposed improvement alternatives. Calibration is the adjustment of the model parameters to improve the model's ability to reproduce observed traffic conditions. It is the required step during any traffic analysis to ensure the model can reproduce local driver behavior and traffic performance characteristics, and calibration should be done prior to evaluating different alternatives. Vissim, like most simulation models, is designed to be flexible enough that an analyst can correctly calibrate the network to match the location conditions at a reasonably accurate level. However, the default values will (almost) never give accurate results for a specific area. Therefore, calibration is required to adjust the Vissim model parameters to replicate the traffic characteristics of the study area.



For the Route 1 study, the calibrated Arlington County PDSP model was used and adjusted to meet project-specific needs. Because the network was trimmed and new geometric elements were added, model calibration was not guaranteed. The calibrated PDSP model was used as the baseline data to which the Route 1 study model was calibrated against.

2.2.2. Calibration Requirements

The VDOT TOSAM 2.0 calibration requirements pertinent to the Route 1 study are provided in **Table 2-1**. These criteria were applied to the AM and PM models to ensure the model outputs reflect localized conditions.

Table 2-1: Vissim Calibration Criteria and Acceptance Targets

Calibration Item	Criteria	Target
Simulated Vehicular Throughput (Intersection Approaches)	Within $\pm 20\%$ for <100 vph	At least 85% of all intersection approaches
	Within $\pm 15\%$ for ≥ 100 vph to < 1000 vph	
	Within $\pm 10\%$ for ≥ 1000 vph to $< 5,000$ vph	
	Within ± 500 vph for $\geq 5,000$ vph	
Simulated Vehicular Throughput (Freeway Ramps and Segments)	Within $\pm 20\%$ for <100 vph	At least 85% ramps and freeway segments
	Within $\pm 15\%$ for ≥ 100 vph to < 1000 vph	
	Within $\pm 10\%$ for ≥ 1000 vph to $< 5,000$ vph	
	Within ± 500 vph for $\geq 5,000$ vph	
Simulated Travel Time	Within $\pm 30\%$ for average travel times on arterials	At least 85% of all travel time routes
Simulated Queue Length	Visually acceptable maximum queue lengths are represented at critical locations	

- **Simulated Vehicular Throughput** was measured against the Arlington County PDSP existing conditions balanced volumes, which reflect 2019 traffic counts.
- **Simulated Travel Time** was measured against identical segments in the calibrated Arlington County PDSP model. The travel time routes included for model calibration are listed below.
 - Northbound/southbound Route 1 between I-395 and Route 233
 - Northbound/southbound Eads Street between 12th Street S and 23rd Street S
 - Northbound/southbound Crystal Drive between 12th Street S and Route 233
 - Eastbound/westbound 12th Street S between S Eads Street and Crystal Drive
 - Eastbound/westbound 15th Street S between S Eads Street and Crystal Drive
 - Eastbound/westbound 18th Street S between S Eads Street and Crystal Drive
 - Eastbound/westbound 20th Street S between S Eads Street and Crystal Drive
 - Eastbound/westbound 23rd Street S between S Eads Street and Crystal Drive



- **Simulated Queue Length** was qualitatively compared against the Arlington County PDSP model and field knowledge of the study area.

2.2.3. Sample Size Requirements

The required sample size (i.e., number of unique simulation runs) was determined based on TOSAM guidance. In accordance with these guidelines, four model runs were performed, and ten MOEs were tested to determine the number of seeds required to obtain a 95 percent confidence level. The MOEs for this evaluation are listed below.

- **Travel time** | Northbound Route 1
- **Travel time** | Southbound Route 1
- **Volume** | Southbound Route 1 between 12th Street S and 15th Street S
- **Volume** | Southbound Route 1 between 18th Street S and 20th Street S
- **Volume** | Northbound Route 1 between 15th Street S and 12th Street S
- **Volume** | Northbound Route 1 between 20th Street and 18th Street S
- **Speed** | Southbound Route 1 between 12th Street S and 15th Street S
- **Speed** | Southbound Route 1 between 18th Street S and 20th Street S
- **Speed** | Northbound Route 1 between 15th Street S and 12th Street S
- **Speed** | Northbound Route 1 between 20th Street S and 18th Street S

The VDOT Sample Size Tool was used to determine 10 random seeds were sufficient for reporting statistically significant average traffic condition performance. The Sample Size Tool results are provided in **Appendix D of the Existing Conditions Report** for AM and PM, respectively.

2.2.4. Driving Behavior

The calibrated driving behaviors in the PDSP model, documented in the PDSP Calibration Memorandum, were maintained throughout the study area.

3. Vissim Model Calibration Results

3.1. AM CALIBRATION SUMMARY

A summary of the AM Existing Conditions Vissim model calibration results is provided in **Table 3-1** and a detailed overview of all metrics are provided in **Appendix D of the Existing Conditions Report**. As shown, all calibration criteria are surpassed, with 97 percent of intersection approaches, 96 percent of freeway and ramp segments, and 100 percent of travel time routes meeting their respective criteria. These calibration results validate that the model is performing sufficiently similar to existing field conditions (as represented in the Arlington County PDSP model). The qualitative calibration assessment of simulated average queue length and average speed are discussed following the table.

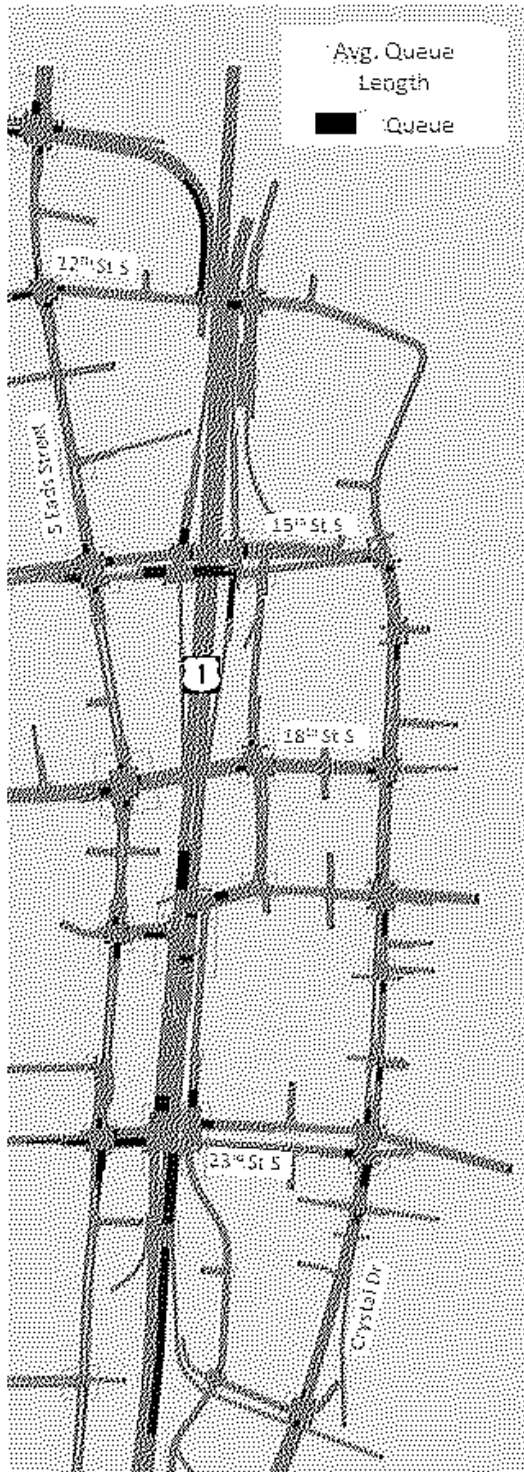
Table 3-1: AM Existing Conditions Calibration Summary

Item	Criteria	Target	Value	Criteria Met
Simulated Vehicular Throughput (Intersection Approaches)	Within $\pm 20\%$ for < 100 vph	85%	97%	Yes
	Within $\pm 15\%$ for ≥ 100 vph to $< 1,000$ vph			
	Within $\pm 10\%$ for $\geq 1,000$ vph to $< 5,000$ vph			
	Within ± 500 for $\geq 5,000$ vph			

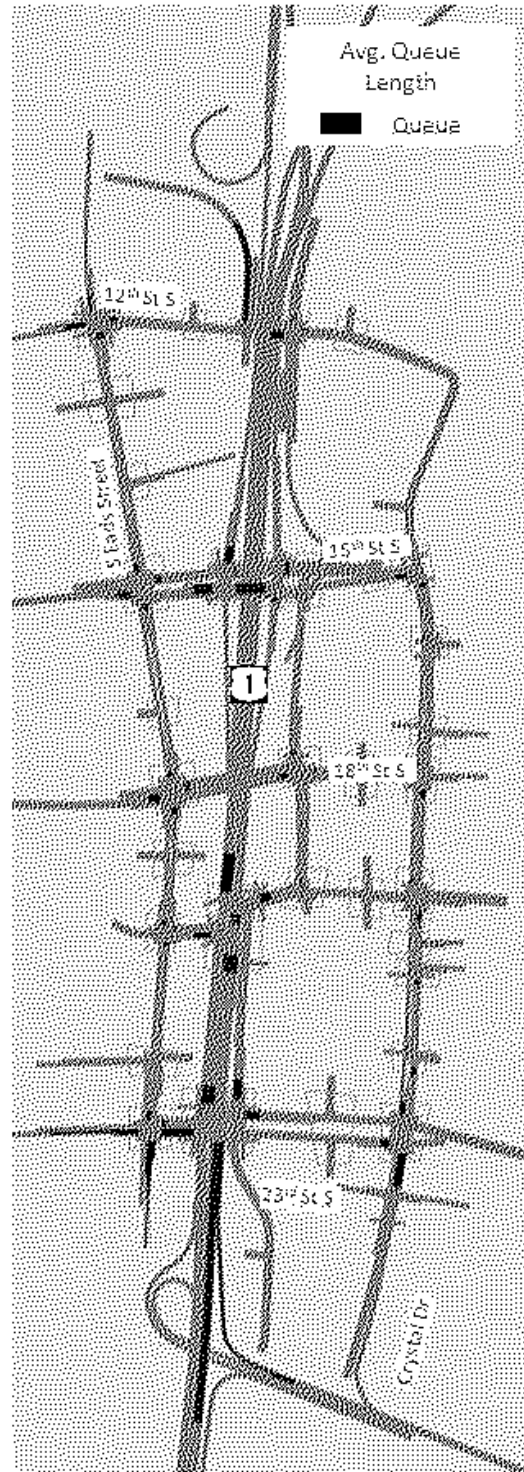


Item	Criteria	Target	Value	Criteria Met
Simulated Vehicular Throughput (Freeway and Ramp Segments)	Within ± 20% for < 100 vph	85%	96%	Yes
	Within ± 15% for ≥ 100 vph to < 1,000 vph			
	Within ± 10% for ≥ 1,000 vph to < 5,000 vph			
	Within ± 500 for ≥ 5,000 vph			
Simulated Travel Time	Within ± 30% for observed travel times on arterials	85%	100%	Yes
Simulated Queue Length	Visually acceptable maximum queue lengths are represented at critical locations			Yes
*Findings Represent Results from 10 Simulation Runs				

The side-by-side comparison of the simulated queue lengths for the PDSP and Route 1 study model in **Figure 3-1** shows similarities between the locations of long queueing throughout the network. Similarities can be seen eastbound on 15th Street S between the southbound and northbound Route 1 ramps and southbound queueing on Army Navy Drive approaching 12th Street S. In addition, the northbound queueing along Route 1 at 23rd Street S and the eastbound congestion that spills back along 23rd Street S to S Eads Street can be seen in the both the PDSP and Route 1 study model. The simulated average speed from the PDSP model aligns with the Route 1 model outputs (see **Figure 3-2**). Notably, northbound Route 1 has slow traffic approaching 23rd Street S and slow speeds along 23rd Street S and S Eads Street. Similar average queue lengths and locations of high/low speeds support that the Route 1 model is satisfactorily calibrated to match the PDSP model.



A. PDSP AM Vissim Average Queue Lengths



B. Route 1 Study AM Vissim Average Queue Lengths

Figure 3-1: PDSP and Route 1 Vissim Average Queue Lengths – AM Peak Hour

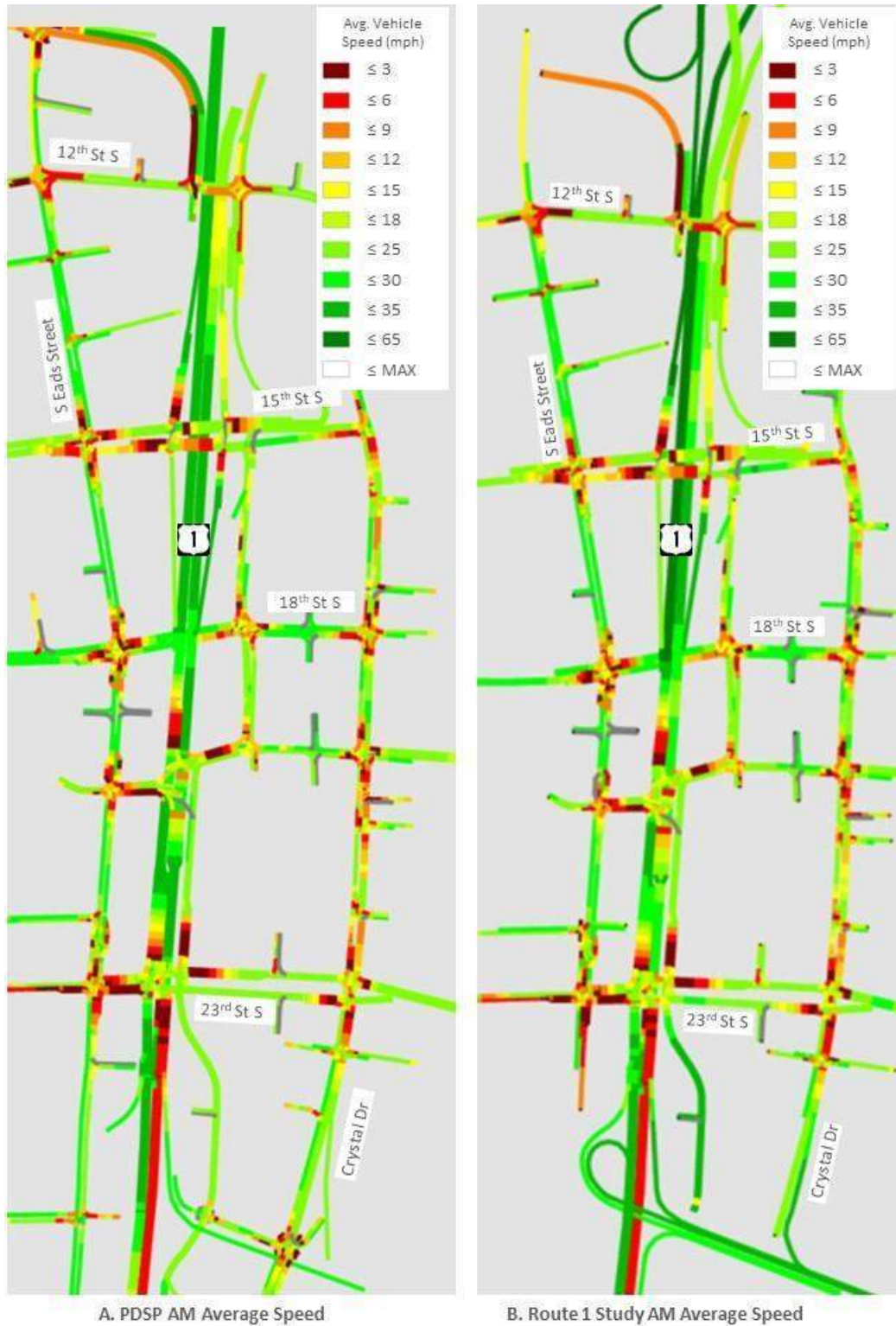


Figure 3-2: PDSP and Route 1 Vissim Average Speeds – AM Peak Hour



3.2. PM CALIBRATION SUMMARY

A summary of the PM Existing Conditions Vissim model calibration results is provided in **Table 3-2** and a detailed overview of all metrics are provided in **Appendix D of the Existing Conditions Report**. As shown, all calibration criteria are surpassed, with 100 percent of intersection approaches, 96 percent of freeway and ramp segments, and 94 percent of travel time routes meeting their respective criteria. These calibration results validate that the model is performing sufficiently similar to existing field conditions (as represented in the Arlington County PDSP model). The qualitative calibration assessment of simulated average queue length and average speed are discussed following the table.

Table 3-2: PM Existing Conditions Calibration Summary

Item	Criteria	Target	Value	Criteria Met
Simulated Vehicular Throughput (Individual Links)	Within ± 20% for < 100 vph	85%	100%	Yes
	Within ± 15% for ≥ 100 vph to < 1,000 vph			
	Within ± 10% for ≥ 1,000 vph to < 5,000 vph			
	Within ± 500 for ≥ 5,000 vph			
Simulated Vehicular Throughput (Freeway and Ramp Segments)	Within ± 20% for < 100 vph	85%	96%	Yes
	Within ± 15% for ≥ 100 vph to < 1,000 vph			
	Within ± 10% for ≥ 1,000 vph to < 5,000 vph			
	Within ± 500 for ≥ 5,000 vph			
Simulated Travel Time	Within ± 30% for observed travel times on arterials	85%	94%	Yes
Simulated Queue Length	Visually acceptable maximum queue lengths are represented at critical locations			Yes
*Findings Represent Results from 10 Simulation Runs				

The side-by-side comparison of the simulated average queue lengths for the PDSP and Route 1 model in **Figure 3-3** shows similarities between the locations of long queueing throughout the network. The similarities can be seen along Route 1 southbound at 15th Street S, 20th Street S, and 23rd Street S. The simulated average speed from the PDSP model aligns with the Route 1 model outputs (see **Figure 3-4**). Similarities can be seen on southbound Route 1 between 20th Street S and 23rd Street S. Similar average queue lengths and locations of high/low speeds support that the Route 1 model is satisfactorily calibrated to match the PDSP model.

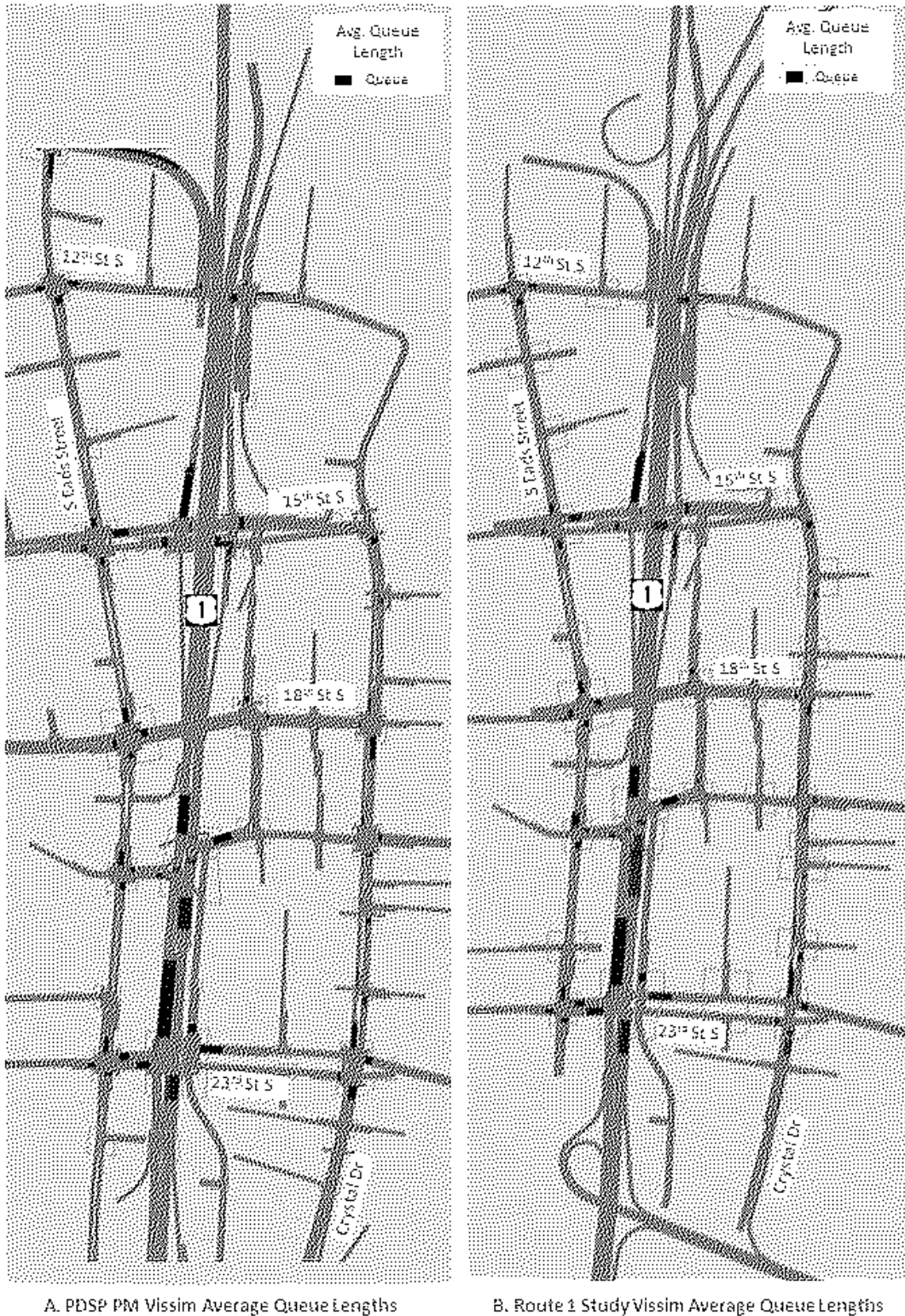
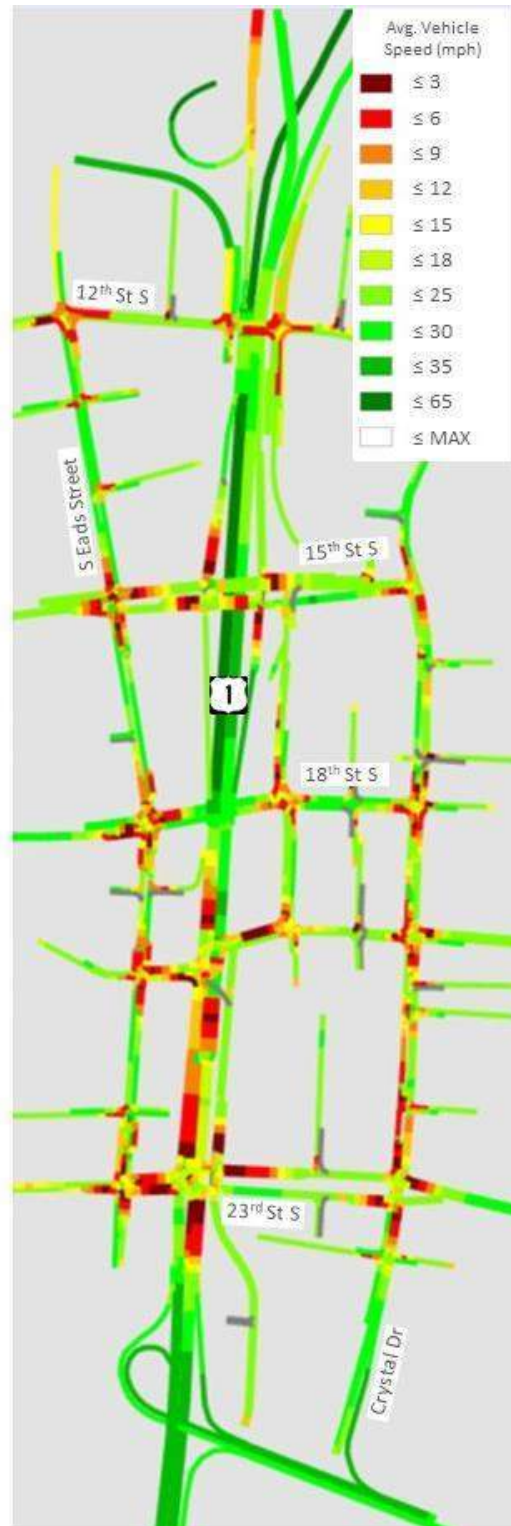


Figure 3-3: PDSP and Route 1 Vissim Average Queue Lengths – PM Peak Hour



A. PDSP PM Average Speed



B. Route 1 Study PM Average Speed

Figure 3-4: PDSP and Route 1 Vissim Average Speeds – PM Peak Hour



4. Conclusions

The Kimley-Horn team updated Arlington County's PDSP existing conditions AM and PM Vissim models by trimming the extents to match the Vissim Operational Analysis Area of the Route 1 study (with the exception of Fern Street, which is evaluated in Synchro 10). The results meet VDOT TOSAM 2.0 calibration requirements and can be further validated with graphic comparisons of average queue lengths and average speeds of the PDSP and Route 1 study model. Vissim calibration results for the AM and PM peak periods demonstrate that the model is appropriately calibrated to be used for Alternatives analysis as part of the Route 1 study.



Appendix D

Vissim and Synchro Results



Appendix D-1

Synchro

Vehicular Traffic



















Operations Results

HCM Signalized Intersection Capacity Analysis

301: S. Fern St. & 12th St. S.

Existing Conditions

Timing Plan: AM Peak Hour






















												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	215	45	30	55	55	40	110	50	160	175	25
Future Volume (vph)	25	215	45	30	55	55	40	110	50	160	175	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	16	12	9	12	12	9	10	10	12	15	10
Total Lost time (s)		6.0		6.0	6.0		6.5	6.5			6.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes		0.91		1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes		0.99		1.00	1.00		0.94	1.00			1.00	
Frt		0.98		1.00	0.93		1.00	0.95			0.99	
Flt Protected		1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)		1841		1593	1723		1415	1593			1907	
Flt Permitted		0.97		0.46	1.00		0.56	1.00			0.78	
Satd. Flow (perm)		1788		772	1723		833	1593			1526	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	25	215	45	30	55	55	40	110	50	160	175	25
RTOR Reduction (vph)	0	10	0	0	40	0	0	14	0	0	3	0
Lane Group Flow (vph)	0	275	0	30	70	0	40	146	0	0	357	0
Confl. Peds. (#/hr)	36		376				65					65
Heavy Vehicles (%)	8%	2%	8%	2%	2%	2%	8%	8%	2%	2%	8%	8%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)		21.4		21.4	21.4		46.1	46.1			46.1	
Effective Green, g (s)		21.4		21.4	21.4		46.1	46.1			46.1	
Actuated g/C Ratio		0.27		0.27	0.27		0.58	0.58			0.58	
Clearance Time (s)		6.0		6.0	6.0		6.5	6.5			6.5	
Vehicle Extension (s)		2.0		2.0	2.0		0.2	0.2			0.2	
Lane Grp Cap (vph)		478		206	460		480	917			879	
v/s Ratio Prot					0.04			0.09				
v/s Ratio Perm		c0.15		0.04			0.05				c0.23	
v/c Ratio		0.57		0.15	0.15		0.08	0.16			0.41	
Uniform Delay, d1		25.4		22.3	22.4		7.5	7.9			9.4	
Progression Factor		1.00		1.00	1.00		0.73	0.71			1.00	
Incremental Delay, d2		1.0		0.1	0.1		0.3	0.4			1.4	
Delay (s)		26.4		22.5	22.4		5.9	5.9			10.8	
Level of Service		C		C	C		A	A			B	
Approach Delay (s)		26.4			22.4			5.9			10.8	
Approach LOS		C			C			A			B	
Intersection Summary												
HCM 2000 Control Delay			16.0				HCM 2000 Level of Service				B	
HCM 2000 Volume to Capacity ratio			0.46									
Actuated Cycle Length (s)			80.0				Sum of lost time (s)			12.5		
Intersection Capacity Utilization			69.0%				ICU Level of Service			C		
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

302: S. Fern St. & 15th St. S.

Existing Conditions

Timing Plan: AM Peak Hour

























												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	20	485	15	55	175	130	20	155	135	115	65	50
Future Volume (vph)	20	485	15	55	175	130	20	155	135	115	65	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	10	10	9	10	10	12	11	8	10	9	12
Total Lost time (s)	6.0	6.0		6.0	6.0			7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.96			1.00	0.96	1.00	0.99	
Flpb, ped/bikes	0.96	1.00		0.98	1.00			1.00	1.00	0.97	1.00	
Frt	1.00	1.00		1.00	0.94			1.00	0.85	1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	
Satd. Flow (prot)	1439	3100		1470	2797			1688	1238	1519	1460	
Flt Permitted	0.57	1.00		0.47	1.00			0.95	1.00	0.65	1.00	
Satd. Flow (perm)	857	3100		725	2797			1616	1238	1034	1460	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	20	485	15	55	175	130	20	155	135	115	65	50
RTOR Reduction (vph)	0	2	0	0	50	0	0	0	105	0	39	0
Lane Group Flow (vph)	20	498	0	55	255	0	0	175	30	115	76	0
Confl. Peds. (#/hr)	35		24	24		35	22		39	39		22
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Bus Blockages (#/hr)	0	0	0	0	3	3	0	0	0	0	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			2			4				4
Permitted Phases	2			2			4		4	4		
Actuated Green, G (s)	49.5	49.5		49.5	49.5			17.5	17.5	17.5	17.5	
Effective Green, g (s)	49.5	49.5		49.5	49.5			17.5	17.5	17.5	17.5	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.22	0.22	0.22	0.22	
Clearance Time (s)	6.0	6.0		6.0	6.0			7.0	7.0	7.0	7.0	
Vehicle Extension (s)	0.2	0.2		0.2	0.2			2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	530	1918		448	1730			353	270	226	319	
v/s Ratio Prot		c0.16			0.09							0.05
v/s Ratio Perm	0.02			0.08				0.11	0.02	c0.11		
v/c Ratio	0.04	0.26		0.12	0.15			0.50	0.11	0.51	0.24	
Uniform Delay, d1	6.0	6.9		6.3	6.4			27.4	25.0	27.5	25.8	
Progression Factor	1.00	1.00		0.74	0.64			0.57	0.56	0.93	0.89	
Incremental Delay, d2	0.1	0.3		0.6	0.2			0.4	0.1	0.6	0.1	
Delay (s)	6.1	7.3		5.2	4.3			16.1	14.1	26.1	23.2	
Level of Service	A	A		A	A			B	B	C	C	
Approach Delay (s)		7.2			4.4			15.2			24.6	
Approach LOS		A			A			B			C	
Intersection Summary												
HCM 2000 Control Delay			11.1			HCM 2000 Level of Service				B		
HCM 2000 Volume to Capacity ratio			0.32									
Actuated Cycle Length (s)			80.0			Sum of lost time (s)				13.0		
Intersection Capacity Utilization			78.5%			ICU Level of Service				D		
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

303: S. Fern St. & S. Hayes St./18th St. S

Existing Conditions

Timing Plan: AM Peak Hour


												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	65	750	135	45	100	50	85	195	135	30	90	15
Future Volume (vph)	65	750	135	45	100	50	85	195	135	30	90	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	11	10	9	10	8	12	10	10	12	11	12
Grade (%)		0%			1%			1%			3%	
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0	7.0		6.5	6.5		6.5	6.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00		1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00	0.96		1.00	0.97		1.00	0.98
Flpb, ped/bikes	0.98	1.00	1.00	0.99	1.00	1.00		1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.99	1.00		0.99	1.00
Satd. Flow (prot)	1481	3231	1330	1483	3104	1242		1606	1341		1649	1443
Flt Permitted	0.69	1.00	1.00	0.34	1.00	1.00		0.85	1.00		0.86	1.00
Satd. Flow (perm)	1074	3231	1330	538	3104	1242		1392	1341		1439	1443
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	65	750	135	45	100	50	85	195	135	30	90	15
RTOR Reduction (vph)	0	0	43	0	0	22	0	0	62	0	0	11
Lane Group Flow (vph)	65	750	92	45	100	28	0	280	73	0	120	4
Confl. Peds. (#/hr)	14		22	22		14	7		18	18		7
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4			4			2			2	
Permitted Phases	4		4	4		4	2		2	2		2
Actuated Green, G (s)	45.3	45.3	45.3	45.3	45.3	45.3		21.2	21.2		21.2	21.2
Effective Green, g (s)	45.3	45.3	45.3	45.3	45.3	45.3		21.2	21.2		21.2	21.2
Actuated g/C Ratio	0.57	0.57	0.57	0.57	0.57	0.57		0.26	0.26		0.26	0.26
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0	7.0		6.5	6.5		6.5	6.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0		0.2	0.2		0.2	0.2
Lane Grp Cap (vph)	608	1829	753	304	1757	703		368	355		381	382
v/s Ratio Prot		c0.23			0.03							
v/s Ratio Perm	0.06		0.07	0.08		0.02		c0.20	0.05		0.08	0.00
v/c Ratio	0.11	0.41	0.12	0.15	0.06	0.04		0.76	0.21		0.31	0.01
Uniform Delay, d1	8.0	9.8	8.1	8.2	7.8	7.7		27.1	22.9		23.6	21.7
Progression Factor	1.00	1.00	1.00	1.02	1.02	1.26		1.00	1.00		1.04	1.00
Incremental Delay, d2	0.3	0.7	0.3	1.0	0.1	0.1		8.1	0.1		0.2	0.0
Delay (s)	8.4	10.5	8.4	9.4	8.0	9.8		35.2	23.0		24.7	21.7
Level of Service	A	B	A	A	A	A		D	C		C	C
Approach Delay (s)		10.0			8.8			31.2			24.3	
Approach LOS		B			A			C			C	
Intersection Summary												
HCM 2000 Control Delay			16.2				HCM 2000 Level of Service		B			
HCM 2000 Volume to Capacity ratio			0.52									
Actuated Cycle Length (s)			80.0				Sum of lost time (s)		13.5			
Intersection Capacity Utilization			78.9%				ICU Level of Service		D			
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

304: S. Fern St. & 23rd St. S.

Existing Conditions

Timing Plan: AM Peak Hour



















												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	100	275	5	5	120	50	5	75	5	100	25	40
Future Volume (vph)	100	275	5	5	120	50	5	75	5	100	25	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	10	12	12	12	12	12	10	12	12	13	12
Grade (%)		-2%			2%			0%			3%	
Total Lost time (s)		5.5			5.5			4.5			4.5	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		1.00			0.98			1.00			0.99	
Flpb, ped/bikes		0.99			1.00			1.00			0.98	
Frt		1.00			0.96			0.99			0.97	
Flt Protected		0.99			1.00			1.00			0.97	
Satd. Flow (prot)		1456			1477			1617			1467	
Flt Permitted		0.87			0.99			0.98			0.81	
Satd. Flow (perm)		1291			1467			1592			1220	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	100	275	5	5	120	50	5	75	5	100	25	40
RTOR Reduction (vph)	0	0	0	0	13	0	0	4	0	0	19	0
Lane Group Flow (vph)	0	380	0	0	162	0	0	81	0	0	146	0
Confl. Peds. (#/hr)	20		10	10		20	10		18	18		10
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Parking (#/hr)	0	0	0	0	0	0				0	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			2			4			4	
Permitted Phases	2			2			4			4		
Actuated Green, G (s)		51.4			51.4			13.6			13.6	
Effective Green, g (s)		51.4			51.4			13.6			13.6	
Actuated g/C Ratio		0.69			0.69			0.18			0.18	
Clearance Time (s)		5.5			5.5			4.5			4.5	
Vehicle Extension (s)		0.2			0.2			2.0			2.0	
Lane Grp Cap (vph)		884			1005			288			221	
v/s Ratio Prot												
v/s Ratio Perm		c0.29			0.11			0.05			c0.12	
v/c Ratio		0.43			0.16			0.28			0.66	
Uniform Delay, d1		5.3			4.2			26.5			28.6	
Progression Factor		1.00			1.67			1.00			1.00	
Incremental Delay, d2		1.5			0.3			0.2			5.6	
Delay (s)		6.8			7.3			26.7			34.2	
Level of Service		A			A			C			C	
Approach Delay (s)		6.8			7.3			26.7			34.2	
Approach LOS		A			A			C			C	
Intersection Summary												
HCM 2000 Control Delay			14.6				HCM 2000 Level of Service			B		
HCM 2000 Volume to Capacity ratio			0.48									
Actuated Cycle Length (s)			75.0				Sum of lost time (s)			10.0		
Intersection Capacity Utilization			63.6%				ICU Level of Service			B		
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

301: S. Fern St. & 12th St. S.

Existing Conditions

Timing Plan: PM Peak Hour






















												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	60	170	95	45	155	80	50	200	35	105	270	10
Future Volume (vph)	60	170	95	45	155	80	50	200	35	105	270	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	16	12	9	12	12	9	10	10	12	15	10
Total Lost time (s)		6.0		6.0	6.0		6.5	6.5			6.5	
Lane Util. Factor		1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes		0.91		1.00	0.88		1.00	0.98			1.00	
Flpb, ped/bikes		0.96		0.85	1.00		0.95	1.00			0.97	
Frt		0.96		1.00	0.95		1.00	0.98			1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00			0.99	
Satd. Flow (prot)		1702		1360	1557		1424	1582			1875	
Flt Permitted		0.87		0.45	1.00		0.54	1.00			0.84	
Satd. Flow (perm)		1499		647	1557		804	1582			1602	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	60	170	95	45	155	80	50	200	35	105	270	10
RTOR Reduction (vph)	0	21	0	0	26	0	0	7	0	0	1	0
Lane Group Flow (vph)	0	304	0	45	209	0	50	228	0	0	384	0
Confl. Peds. (#/hr)	177		156	156		177	62		84	84		62
Heavy Vehicles (%)	8%	2%	8%	2%	2%	2%	8%	8%	2%	2%	8%	8%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)		22.9		22.9	22.9		44.6	44.6			44.6	
Effective Green, g (s)		22.9		22.9	22.9		44.6	44.6			44.6	
Actuated g/C Ratio		0.29		0.29	0.29		0.56	0.56			0.56	
Clearance Time (s)		6.0		6.0	6.0		6.5	6.5			6.5	
Vehicle Extension (s)		2.0		2.0	2.0		0.2	0.2			0.2	
Lane Grp Cap (vph)		429		185	445		448	881			893	
v/s Ratio Prot					0.13			0.14				
v/s Ratio Perm		c0.20		0.07			0.06				c0.24	
v/c Ratio		0.71		0.24	0.47		0.11	0.26			0.43	
Uniform Delay, d1		25.6		21.9	23.5		8.4	9.2			10.3	
Progression Factor		1.00		1.34	1.32		0.64	0.60			1.00	
Incremental Delay, d2		4.4		0.2	0.2		0.5	0.7			1.5	
Delay (s)		29.9		29.5	31.4		5.8	6.2			11.8	
Level of Service		C		C	C		A	A			B	
Approach Delay (s)		29.9			31.1			6.1			11.8	
Approach LOS		C			C			A			B	
Intersection Summary												
HCM 2000 Control Delay			19.4			HCM 2000 Level of Service				B		
HCM 2000 Volume to Capacity ratio			0.52									
Actuated Cycle Length (s)			80.0			Sum of lost time (s)			12.5			
Intersection Capacity Utilization			100.2%			ICU Level of Service			G			
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

302: S. Fern St. & 15th St. S.

Existing Conditions

Timing Plan: PM Peak Hour

























												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	75	255	25	130	475	145	20	130	55	125	225	75
Future Volume (vph)	75	255	25	130	475	145	20	130	55	125	225	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	10	10	9	10	10	12	11	8	10	9	12
Total Lost time (s)	6.0	6.0		6.0	6.0			7.0	7.0	7.0	7.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00	1.00	1.00	
Frpb, ped/bikes	1.00	0.99		1.00	0.98			1.00	0.93	1.00	0.99	
Flpb, ped/bikes	0.97	1.00		0.95	1.00			1.00	1.00	0.96	1.00	
Frt	1.00	0.99		1.00	0.96			1.00	0.85	1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	
Satd. Flow (prot)	1457	3051		1423	2926			1685	1211	1490	1506	
Flt Permitted	0.40	1.00		0.58	1.00			0.92	1.00	0.66	1.00	
Satd. Flow (perm)	619	3051		868	2926			1564	1211	1038	1506	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	75	255	25	130	475	145	20	130	55	125	225	75
RTOR Reduction (vph)	0	6	0	0	25	0	0	0	41	0	20	0
Lane Group Flow (vph)	75	274	0	130	595	0	0	150	14	125	280	0
Confl. Peds. (#/hr)	40		42	42		40	41		64	64		41
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Bus Blockages (#/hr)	0	0	0	0	3	3	0	0	0	0	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			2			4				4
Permitted Phases	2			2			4		4	4		
Actuated Green, G (s)	46.3	46.3		46.3	46.3			20.7	20.7	20.7	20.7	
Effective Green, g (s)	46.3	46.3		46.3	46.3			20.7	20.7	20.7	20.7	
Actuated g/C Ratio	0.58	0.58		0.58	0.58			0.26	0.26	0.26	0.26	
Clearance Time (s)	6.0	6.0		6.0	6.0			7.0	7.0	7.0	7.0	
Vehicle Extension (s)	0.2	0.2		0.2	0.2			2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	358	1765		502	1693			404	313	268	389	
v/s Ratio Prot		0.09			c0.20						c0.19	
v/s Ratio Perm	0.12			0.15				0.10	0.01	0.12		
v/c Ratio	0.21	0.16		0.26	0.35			0.37	0.05	0.47	0.72	
Uniform Delay, d1	8.1	7.8		8.3	8.9			24.3	22.2	25.0	27.0	
Progression Factor	1.00	1.00		0.40	0.35			0.98	1.12	0.88	0.89	
Incremental Delay, d2	1.3	0.2		0.9	0.4			0.2	0.0	0.4	4.8	
Delay (s)	9.4	8.0		4.2	3.5			24.1	25.0	22.4	28.8	
Level of Service	A	A		A	A			C	C	C	C	
Approach Delay (s)		8.3			3.6			24.3			26.9	
Approach LOS		A			A			C			C	
Intersection Summary												
HCM 2000 Control Delay			12.7			HCM 2000 Level of Service				B		
HCM 2000 Volume to Capacity ratio			0.46									
Actuated Cycle Length (s)			80.0			Sum of lost time (s)				13.0		
Intersection Capacity Utilization			89.7%			ICU Level of Service				E		
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

303: S. Fern St. & S. Hayes St./18th St. S

Existing Conditions

Timing Plan: PM Peak Hour

















												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 							
Traffic Volume (vph)	45	400	325	80	205	65	40	95	25	30	335	15
Future Volume (vph)	45	400	325	80	205	65	40	95	25	30	335	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	9	11	10	9	10	8	12	10	10	12	11	12
Grade (%)		0%			1%			1%			3%	
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0	7.0		6.5	6.5		6.5	6.5
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00		1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00	0.96		1.00	0.95		1.00	0.97
Flpb, ped/bikes	0.99	1.00	1.00	0.98	1.00	1.00		1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.99	1.00		1.00	1.00
Satd. Flow (prot)	1484	3231	1323	1469	3104	1242		1606	1324		1664	1433
Flt Permitted	0.62	1.00	1.00	0.51	1.00	1.00		0.84	1.00		0.97	1.00
Satd. Flow (perm)	974	3231	1323	784	3104	1242		1366	1324		1622	1433
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	45	400	325	80	205	65	40	95	25	30	335	15
RTOR Reduction (vph)	0	0	228	0	0	46	0	0	12	0	0	7
Lane Group Flow (vph)	45	400	97	80	205	19	0	135	13	0	365	8
Confl. Peds. (#/hr)	14		26	26		14	12		28	28		12
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4			4			2			2	
Permitted Phases	4		4	4		4	2		2	2		2
Actuated Green, G (s)	23.8	23.8	23.8	23.8	23.8	23.8		42.7	42.7		42.7	42.7
Effective Green, g (s)	23.8	23.8	23.8	23.8	23.8	23.8		42.7	42.7		42.7	42.7
Actuated g/C Ratio	0.30	0.30	0.30	0.30	0.30	0.30		0.53	0.53		0.53	0.53
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0	7.0		6.5	6.5		6.5	6.5
Vehicle Extension (s)	2.0	2.0	2.0	2.0	2.0	2.0		0.2	0.2		0.2	0.2
Lane Grp Cap (vph)	289	961	393	233	923	369		729	706		865	764
v/s Ratio Prot		c0.12			0.07							
v/s Ratio Perm	0.05		0.07	0.10		0.02		0.10	0.01		c0.23	0.01
v/c Ratio	0.16	0.42	0.25	0.34	0.22	0.05		0.19	0.02		0.42	0.01
Uniform Delay, d1	20.7	22.5	21.3	22.0	21.1	20.1		9.6	8.8		11.2	8.7
Progression Factor	1.00	1.00	1.00	0.73	0.84	0.64		1.00	1.00		0.64	1.00
Incremental Delay, d2	0.1	0.1	0.1	0.3	0.0	0.0		0.6	0.0		1.4	0.0
Delay (s)	20.8	22.6	21.4	16.4	17.8	12.9		10.2	8.8		8.6	8.8
Level of Service	C	C	C	B	B	B		B	A		A	A
Approach Delay (s)		22.0			16.6			10.0			8.6	
Approach LOS		C			B			A			A	
Intersection Summary												
HCM 2000 Control Delay			16.6									
HCM 2000 Volume to Capacity ratio			0.42									
Actuated Cycle Length (s)			80.0									
Intersection Capacity Utilization			81.8%									
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

304: S. Fern St. & 23rd St. S.

Existing Conditions

Timing Plan: PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	170	25	5	360	40	10	15	5	230	185	110
Future Volume (vph)	45	170	25	5	360	40	10	15	5	230	185	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	10	12	12	12	12	12	10	12	12	13	12
Grade (%)		-2%			2%			0%			3%	
Total Lost time (s)		5.5			5.5			4.5			4.5	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		0.99			0.99			0.99			0.99	
Flpb, ped/bikes		1.00			1.00			1.00			0.97	
Frt		0.99			0.99			0.98			0.97	
Flt Protected		0.99			1.00			0.98			0.98	
Satd. Flow (prot)		1441			1533			1551			1472	
Flt Permitted		0.88			1.00			0.87			0.84	
Satd. Flow (perm)		1275			1529			1372			1271	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	45	170	25	5	360	40	10	15	5	230	185	110
RTOR Reduction (vph)	0	6	0	0	6	0	0	3	0	0	14	0
Lane Group Flow (vph)	0	234	0	0	399	0	0	27	0	0	511	0
Confl. Peds. (#/hr)	28		22	22		28	16		33	33		16
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Parking (#/hr)	0	0	0	0	0	0				0	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			2			4			4	
Permitted Phases	2			2			4			4		
Actuated Green, G (s)		30.5			30.5			29.5			29.5	
Effective Green, g (s)		30.5			30.5			29.5			29.5	
Actuated g/C Ratio		0.44			0.44			0.42			0.42	
Clearance Time (s)		5.5			5.5			4.5			4.5	
Vehicle Extension (s)		0.2			0.2			2.0			2.0	
Lane Grp Cap (vph)		555			666			578			535	
v/s Ratio Prot												
v/s Ratio Perm		0.18			c0.26			0.02			c0.40	
v/c Ratio		0.42			0.60			0.05			0.96	
Uniform Delay, d1		13.7			15.1			12.0			19.6	
Progression Factor		1.00			1.12			1.00			1.00	
Incremental Delay, d2		2.3			3.5			0.0			27.6	
Delay (s)		16.0			20.5			12.0			47.2	
Level of Service		B			C			B			D	
Approach Delay (s)		16.0			20.5			12.0			47.2	
Approach LOS		B			C			B			D	
Intersection Summary												
HCM 2000 Control Delay			31.1									
HCM 2000 Volume to Capacity ratio			0.77									
Actuated Cycle Length (s)			70.0									
Intersection Capacity Utilization			85.2%									
Analysis Period (min)			15									
c Critical Lane Group												



Appendix D-2

Vissim

Vehicular Traffic

Operations Results

Intersection Delay and Estimated LOS

AM Peak Hour



ID	Intersection	Approach	Average Delay (sec/veh)	Approach LOS	Intersection Delay	Intersection LOS
101	15th Street and Route 1 Southbound Ramp (Signalized)	NB	-	-	29.2	C
		SB	33.0	C		
		EB	29.7	C		
		WB	9.4	A		
102	15th Street and Route 1 Northbound Ramp (Signalized)	NB	27.9	C	13.4	B
		SB	-	-		
		EB	12.3	B		
		WB	12.1	B		
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	NB	3.2	A	18.3	B
		SB	36.5	D		
		EB	-	-		
		WB	32.4	C		
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	NB	15.0	B	12.4	B
		SB	1.2	A		
		EB	67.8	E		
		WB	-	-		
103		Total			15.4	B
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	NB	-	-	23.4	C
		SB	131.2	F		
		EB	0.3	A		
		WB	52.5	D		
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	NB	211.5	F	107.6	F
		SB	20.8	C		
		EB	41.6	D		
104		Total			106.7	F
201	12th Street and Eads Street (Signalized)	NB	14.6	B	25.9	C
		SB	20.4	C		
		EB	40.9	D		
		WB	36.3	D		
202	12th Street and Army Navy Dr (Unsignalized)	NB	20.9	C	48.4	D
		SB	210.8	F		
		EB	3.0	A		
		WB	1.0	A		
203	12th Street and Long Bridge Dr / Clark Street (Unsignalized)	NB	24.0	C	13.6	B
		SB	17.2	C		
		EB	11.5	B		
		WB	14.8	B		
204	15th Street and Eads Street (Signalized)	NB	12.9	B	19.0	B
		SB	22.3	C		
		EB	23.7	C		
		WB	15.7	B		
205	15th Street and Bell Street (Unsignalized)	NB	-	-	1.9	A
		SB	-	-		
		EB	1.1	A		
		WB	3.5	A		
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	NB	-	-	4.2	A
		SB	1.1	A		
		EB	6.8	A		
		WB	0.3	A		

ID	Intersection	Approach	Average Delay (sec/veh)	Approach LOS	Intersection Delay	Intersection LOS
207	15th Street and Crystal Dr (Signalized)	NB	9.0	A	12.6	B
		SB	15.2	B		
		EB	16.2	B		
		WB	-	-		
208	18th Street and Eads Street (Signalized)	NB	16.4	B	19.1	B
		SB	14.4	B		
		EB	21.1	C		
		WB	22.5	C		
209	18th Street and Bell Street (Signalized)	NB	23.7	C	15.3	B
		SB	19.8	B		
		EB	14.3	B		
		WB	12.3	B		
210	18th Street and Crystal Dr (Signalized)	NB	13.9	B	12.4	B
		SB	10.9	B		
		EB	11.3	B		
		WB	14.7	B		
211	20th Street and Eads Street (Signalized)	NB	6.7	A	10.5	B
		SB	13.6	B		
		EB	22.3	C		
		WB	12.8	B		
212	20th Street and Bell Street (Unsignalized)	NB	9.9	A	6.7	A
		SB	10.6	B		
		EB	2.8	A		
		WB	3.7	A		
213	20th Street and Crystal Dr (Signalized)	NB	10.5	B	14.7	B
		SB	20.1	C		
		EB	16.4	B		
		WB	11.7	B		
214	23rd Street and Eads Street (Signalized)	NB	65.9	E	78.9	E
		SB	38.2	D		
		EB	167.2	F		
		WB	16.6	B		
215	23rd Street and Crystal Drive (Signalized)	NB	37.4	D	31.8	C
		SB	25.8	C		
		EB	27.2	C		
		WB	24.7	C		

*Results show the average from 10 simulation runs.

*Reported level of service from Vissim is not calculated with passenger car equivalents; thus, the LOS is not representative of HCM LOS.

Intersection Queue Lengths

AM Peak Hour:



Intersection		Approach	Vissim Average Queue (ft)	Vissim Max Queue (ft)
101	15th Street and Route 1 Southbound Ramp (Signalized)	NB	0	0
		SB	67	298
		EB	84	410
		WB	8	77
102	15th Street and Route 1 Northbound Ramp (Signalized)	NB	13	121
		SB	0	0
		EB	126	275
		WB	19	149
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	NB	36	210
		SB	163	558
		EB	0	0
		WB	44	229
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	NB	78	690
		SB	4	184
		EB	72	251
		WB	0	0
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	NB	0	0
		SB	81	213
		EB	1	142
		WB	60	289
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	NB	1224	1681
		SB	88	470
		EB	272	544
		EB	272	544
		WB	4	109
201	12th Street and Eads Street (Signalized)	NB	22	244
		SB	70	500
		EB	94	473
		WB	35	173
202	12th Street and Army Navy Dr (Unsignalized)	NB	1	53
		SB	450	893
		EB	14	284
		WB	0	64
203	12th Street and Long Bridge Dr / Clark Street (Unsignalized)	NB	4	72
		SB	21	157
		EB	51	268
		WB	26	244
204	15th Street and Eads Street (Signalized)	NB	25	275
		SB	32	213
		EB	66	403
		WB	21	162
205	15th Street and Bell Street (Unsignalized)	NB	0	0
		SB	0	0
		EB	1	175
		WB	0	47

Intersection		Approach	Vissim Average Queue (ft)	Vissim Max Queue (ft)
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	NB	0	0
		SB	0	5
		EB	0	49
		WB	0	129
207	15th Street and Crystal Dr (Signalized)	NB	17	205
		SB	10	152
		EB	47	199
		WB	0	0
208	18th Street and Eads Street (Signalized)	NB	32	280
		SB	14	187
		EB	44	285
		WB	12	102
209	18th Street and Bell Street (Signalized)	NB	7	101
		SB	15	138
		EB	37	305
		WB	5	91
210	18th Street and Crystal Dr (Signalized)	NB	32	265
		SB	20	130
		EB	19	158
		WB	1	45
211	20th Street and Eads Street (Signalized)	NB	13	247
		SB	16	176
		EB	3	69
		WB	8	90
212	20th Street and Bell Street (Unsignalized)	NB	1	82
		SB	23	138
		EB	2	160
		WB	1	126
213	20th Street and Crystal Dr (Signalized)	NB	40	197
		SB	28	300
		EB	12	149
		WB	1	35
214	23rd Street and Eads Street (Signalized)	NB	231	500
		SB	36	228
		EB	395	922
		WB	11	98
215	23rd Street and Crystal Drive (Signalized)	NB	152	494
		SB	54	300
		EB	39	261
		WB	2	36

Travel Time | Segment-by-Segment

AM Peak Period:

85% of All Arterial Travel Time Segments	Number of Passing Segments	Percent	Target	Target Met
Within \pm 30% for observed travel times on arterials	16 of 16	100%	85%	Yes

Vehicle Segment-by-Segment Travel Time Comparison					
Segment ID	Route	PDSP Calibrated Model Data	Average Vissim	Difference	
		(MM:SS)	(MM:SS)	(MM:SS)	(%)
101	Route 1 NB from VA-233 to 12th St	04:58	05:08	00:10	3%
102	Route 1 SB from 12th St to VA-233	02:24	02:06	-00:18	-13%
201	12th St EB from Eads St to Crystal Dr	00:55	00:56	00:01	2%
202	12th St WB from Crystal Dr to Eads St	01:12	01:13	00:01	1%
203	15th St EB from Eads St to Crystal Dr	01:05	00:56	-00:09	-14%
204	15th St WB Crystal Dr to Eads St	00:59	00:58	-00:01	-2%
205	18th St EB from Eads St to Crystal Dr	00:47	00:39	-00:08	-17%
206	18th St WB Crystal Dr to Eads St	00:43	00:36	-00:07	-16%
207	20th St EB from Eads St to Crystal Dr	02:18	02:03	-00:15	-11%
208	20th St WB Crystal Dr to Eads St	01:29	01:31	00:02	2%
209	23rd St EB from Eads St to Crystal Dr	01:36	01:33	-00:03	-3%
210	23rd St WB Crystal Dr to Eads St	01:26	01:30	00:04	5%
301	Eads St NB from 23rd St to 12th St	02:33	02:14	-00:19	-12%
302	Eads St SB from 12th St to 23rd St	02:40	02:16	-00:24	-15%
303	Crystal Dr NB from 23rd St to 12th St	02:46	02:14	-00:32	-19%
304	Crystal Dr SB from 12th St to 23rd St	03:05	02:48	-00:17	-9%
*Results show the average from 10 simulation runs.					

Intersection Delay and Estimated LOS

PM Peak Hour



ID	Intersection	Approach	Average Delay (sec/veh)	Approach LOS	Intersection Delay	Intersection LOS
101	15th Street and Route 1 Southbound Ramp (Signalized)	NB	-	-	29.7	C
		SB	43.0	D		
		EB	22.8	C		
		WB	2.0	A		
102	15th Street and Route 1 Northbound Ramp (Signalized)	NB	29.4	C	13.7	B
		SB	-	-		
		EB	9.2	A		
		WB	11.7	B		
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	NB	0.3	A	22.3	C
		SB	35.3	D		
		EB	-	-		
		WB	56.1	E		
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	NB	44.7	D	25.0	C
		SB	4.2	A		
		EB	38.3	D		
		WB	-	-		
103		Total			23.6	B
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	NB	-	-	38.5	D
		SB	54.0	D		
		EB	0.9	A		
		WB	53.8	D		
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	NB	64.2	E	52.0	D
		SB	53.1	D		
		EB	35.7	D		
104		Total			54.6	F
201	12th Street and Eads Street (Signalized)	NB	12.1	B	18.6	B
		SB	16.2	B		
		EB	24.4	C		
		WB	24.7	C		
202	12th Street and Army Navy Dr (Unsignalized)	NB	7.6	A	4.0	A
		SB	15.5	C		
		EB	0.7	A		
		WB	1.6	A		
203	12th Street and Long Bridge Dr / Clark Street (Unsignalized)	NB	25.3	D	18.7	B
		SB	13.2	B		
		EB	18.9	C		
		WB	19.1	C		
204	15th Street and Eads Street (Signalized)	NB	21.0	C	19.7	B
		SB	21.3	C		
		EB	16.3	B		
		WB	20.0	B		
205	15th Street and Bell Street (Unsignalized)	NB	-	-	2.8	A
		SB	-	-		
		EB	0.6	A		
		WB	4.2	A		
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	NB	-	-	0.9	A
		SB	1.0	A		
		EB	1.5	A		
		WB	0.3	A		

ID	Intersection	Approach	Average Delay (sec/veh)	Approach LOS	Intersection Delay	Intersection LOS
207	15th Street and Crystal Dr (Signalized)	NB	13.0	B	15.4	B
		SB	21.2	C		
		EB	16.3	B		
		WB	-	-		
208	18th Street and Eads Street (Signalized)	NB	16.7	B	22.9	C
		SB	16.0	B		
		EB	36.6	D		
		WB	24.0	C		
209	18th Street and Bell Street (Signalized)	NB	25.7	C	9.3	A
		SB	8.2	A		
		EB	10.8	B		
		WB	4.9	A		
210	18th Street and Crystal Dr (Signalized)	NB	16.5	B	15.3	B
		SB	14.9	B		
		EB	12.5	B		
		WB	14.0	B		
211	20th Street and Eads Street (Signalized)	NB	20.6	C	17.2	B
		SB	16.2	B		
		EB	15.7	B		
		WB	16.9	B		
212	20th Street and Bell Street (Unsignalized)	NB	12.1	B	10.0	B
		SB	12.8	B		
		EB	2.1	A		
		WB	10.2	B		
213	20th Street and Crystal Dr (Signalized)	NB	13.2	B	17.5	B
		SB	25.3	C		
		EB	16.6	B		
		WB	13.2	B		
214	23rd Street and Eads Street (Signalized)	NB	17.4	B	19.2	B
		SB	21.2	C		
		EB	19.3	B		
		WB	17.0	B		
215	23rd Street and Crystal Drive (Signalized)	NB	33.3	C	36.3	D
		SB	43.5	D		
		EB	30.4	C		
		WB	34.0	C		

*Results show the average from 10 simulation runs.

*Reported level of service from Vissim is not calculated with passenger car equivalents; thus, the LOS is not representative of HCM LOS.

Intersection Queue Lengths

PM Peak Hour:



Intersection		Approach	Vissim Average Queue (ft)	Vissim Max Queue (ft)
101	15th Street and Route 1 Southbound Ramp (Signalized)	NB	0	0
		SB	253	1106
		EB	26	169
		WB	3	49
102	15th Street and Route 1 Northbound Ramp (Signalized)	NB	75	291
		SB	0	0
		EB	75	291
		WB	28	127
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	NB	31	270
		SB	152	550
		EB	0	0
		WB	79	246
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	NB	266	861
		SB	18	177
		EB	40	181
		WB	0	0
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	NB	0	0
		SB	39	162
		EB	1	171
		WB	107	362
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	NB	164	544
		SB	345	843
		EB	153	549
		EB	153	549
		WB	4	113
201	12th Street and Eads Street (Signalized)	NB	33	361
		SB	26	213
		EB	33	241
		WB	49	286
202	12th Street and Army Navy Dr (Unsignalized)	NB	1	57
		SB	9	126
		EB	1	86
		WB	2	208
203	12th Street and Long Bridge Dr / Clark Street (Unsignalized)	NB	29	201
		SB	13	149
		EB	28	222
		WB	68	292
204	15th Street and Eads Street (Signalized)	NB	40	335
		SB	37	264
		EB	21	178
		WB	62	271
205	15th Street and Bell Street (Unsignalized)	NB	0	0
		SB	0	0
		EB	0	84
		WB	2	82

Intersection		Approach	Vissim Average Queue (ft)	Vissim Max Queue (ft)
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	NB	0	0
		SB	0	27
		EB	0	4
		WB	0	0
207	15th Street and Crystal Dr (Signalized)	NB	31	206
		SB	27	244
		EB	23	144
		WB	0	0
208	18th Street and Eads Street (Signalized)	NB	26	235
		SB	62	367
		EB	66	310
		WB	25	133
209	18th Street and Bell Street (Signalized)	NB	6	91
		SB	22	187
		EB	8	158
		WB	6	77
210	18th Street and Crystal Dr (Signalized)	NB	46	453
		SB	42	221
		EB	11	145
		WB	1	37
211	20th Street and Eads Street (Signalized)	NB	38	299
		SB	67	376
		EB	4	72
		WB	16	122
212	20th Street and Bell Street (Unsignalized)	NB	1	54
		SB	21	178
		EB	0	45
		WB	15	253
213	20th Street and Crystal Dr (Signalized)	NB	33	195
		SB	79	425
		EB	4	80
		WB	15	135
214	23rd Street and Eads Street (Signalized)	NB	21	225
		SB	64	349
		EB	39	328
		WB	44	306
215	23rd Street and Crystal Drive (Signalized)	NB	76	385
		SB	163	325
		EB	15	131
		WB	33	169

Travel Time | Segment-by-Segment

PM Peak Period:

85% of All Arterial Travel Time Segments	Number of Passing Segments	Percent	Target	Target Met
Within \pm 30% for observed travel times on arterials	15 of 16	94%	85%	Yes

Vehicle Segment-by-Segment Travel Time Comparison					
Segment ID	Route	PDSP Calibrated Model Data	Average Vissim	Difference	
		(MM:SS)	(MM:SS)	(MM:SS)	(%)
101	Route 1 NB from VA-233 to 12th St	03:18	03:42	00:24	12%
102	Route 1 SB from 12th St to VA-233	03:36	03:26	-00:10	-5%
201	12th St EB from Eads St to Crystal Dr	00:55	00:53	-00:02	-4%
202	12th St WB from Crystal Dr to Eads St	01:28	01:24	-00:04	-5%
203	15th St EB from Eads St to Crystal Dr	00:57	00:59	00:02	4%
204	15th St WB Crystal Dr to Eads St	01:08	01:06	-00:02	-3%
205	18th St EB from Eads St to Crystal Dr	00:34	00:36	00:02	6%
206	18th St WB Crystal Dr to Eads St	00:46	00:37	-00:09	-20%
207	20th St EB from Eads St to Crystal Dr	01:47	01:42	-00:05	-5%
208	20th St WB Crystal Dr to Eads St	01:48	01:44	-00:04	-4%
209	23rd St EB from Eads St to Crystal Dr	02:47	01:32	-01:15	-45%
210	23rd St WB Crystal Dr to Eads St	01:32	01:24	-00:08	-9%
301	Eads St NB from 23rd St to 12th St	02:34	02:38	00:04	3%
302	Eads St SB from 12th St to 23rd St	02:35	02:29	-00:06	-4%
303	Crystal Dr NB from 23rd St to 12th St	02:40	02:17	-00:23	-14%
304	Crystal Dr SB from 12th St to 23rd St	03:43	03:56	00:13	6%

*Results show the average from 10 simulation runs.



Appendix D-3

Vissim

Transit Operations

Results

Transit Intersection Performance

AM Peak Hour



ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
101	15th Street and Route 1 Southbound Ramp (Signalized)	SB	SBL	6	6	60.2	60.2
		EB	EBT	9	9	23.3	23.3
102	15th Street and Route 1 Northbound Ramp (Signalized)	EB	EBL	2	15	22.3	7.1
			EBT	13		4.7	
		WB	WBR	6	6	12.3	12.3
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	WB	WBL-Clark	12	12	49.1	49.1
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	SB	SBT-Clark	12	12	2.1	2.1
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	SB	SBT	7	11	159.7	181.0
			SBR	4		218.3	
		EB	EBT	5	5	0.1	0.1
		WB	WBT	2	2	39.0	39.0

ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	EB	EBT	5	5	83.4	83.4
		WB	WBT	6	6	1.6	1.6
201	12th Street and Eads Street (Signalized)	NB	NBT	5	5	21.1	21.1
		SB	SBT	10	10	21.2	21.2
204	15th Street and Eads Street (Signalized)	NB	NBL	2	4	21.1	24.4
			NBT	2		27.7	
		SB	SBL	9	17	27.3	23.4
			SBT	3		33.9	
			SBR	5		10.1	
		EB	EBL	3	7	32.2	22.2
			EBR	4		14.8	
205	15th Street and Bell Street (Unsignalized)	EB	EBR	13	13	0.0	0.0
		WB	WBT	6	6	3.7	3.7
			WBL	4		0.7	
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	WB	WBT	10	10	0.2	0.2
207	15th Street and Crystal Dr (Signalized)	NB	NBL	10	10	12.5	12.5
208	18th Street and Eads Street (Signalized)	NB	NBT	2	2	16.4	16.4
		SB	SBL	5	7	24.4	21.7
			SBT	2		15.2	
		WB	WBT	7	7	15.0	15.0

ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
209	18th Street and Bell Street (Signalized)	SB	SBL	10	17	48.4	43.5
			SBT	7		36.5	
			SBR	0		-	
		EB	EBT	5	5	26.9	26.9
210	18th Street and Crystal Dr (Signalized)	NB	NBT	4	4	6.5	6.5
		EB	EBL	6	15	10.5	8.2
			EBR	9		6.7	
211	20th Street and Eads Street (Signalized)	NB	NBT	2	2	4.8	4.8
		SB	SBT	2	2	15.6	15.6
212	20th Street and Bell Street (Unsignalized)	SB	SBR	7	7	11.3	11.3
		WB	WBT	4	4	21.9	21.9
213	20th Street and Crystal Dr (Signalized)	NB	NBT	4	4	19.3	19.3
		SB	SBT	5	9	11.1	18.2
			SBR	4		27.1	
214	23rd Street and Eads Street (Signalized)	SB	SBR	2	2	16.5	16.5
		EB	EBL	2	7	152.4	170.9
			EBT	5		178.3	
		WB	WBT	4	6	20.0	16.2
			WBR	2		8.4	
215	23rd Street and Crystal Drive (Signalized)	NB	NBT	7	7	28.8	28.8
		SB	SBR	5	5	26.5	26.5
		EB	EBL	5	5	48.3	48.3

Transit Travel Time

AM Peak Period:



Transit Route	Average VISSIM
	(MM:SS)
10A NB (Alexandria-Pentagon)(WMATA)	05:24
10A SB (Alexandria-Pentagon)(WMATA)	05:30
23B EB (McLean-Crystal City)(WMATA)	10:26
23B WB (McLean-Crystal City)(WMATA)	09:16
Art 43 (Crystal City - Courthouse)(ART)	06:51
MW1 NB (Metroway-Potomac Yard)(WMATA)	03:53
MW1 SB Metroway-Potomac Yard)(WMATA)	09:09
599 PM WB (Pentagon - Crystal City Express)(Fairfax)	04:40
L-200 PM (Lake Ridge-Pentagon & Crystal City Express)(OmniRide)	04:45
7A SB (Lincolnia - North Fairlington)(WMATA)	01:52
7F SB (Lincolnia - North Fairlington)(WMATA)	01:48
7Y NB (Lincolnia - North Fairlington)(WMATA)	04:22
23A EB (McLean - Crystal City)(WMATA)	12:00
23A WB (McLean - Crystal City)(WMATA)	10:09
22A EB (Barcroft - South Fairlington)(WMATA)	01:48
22A WB (Barcroft - South Fairlington)(WMATA)	01:39
7A NB (Lincolnia - North Fairlington)(WMATA)	01:41
682 (East Gate via Dulles South)(LC)	09:10
882 (Leesburg via Dulles North)(LC)	09:47

Transit Intersection Performance

PM Peak Hour



ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
101	15th Street and Route 1 Southbound Ramp (Signalized)	SB	SBL	6	6	84.4	84.4
		EB	EBT	7	7	33.2	33.2
102	15th Street and Route 1 Northbound Ramp (Signalized)	EB	EBL	0	13	-	6.7
			EBT	13		6.7	
		WB	WBR	5	5	10.9	10.9
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	WB	WBL-Clark	14	14	57.6	57.6
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	SB	SBT-Clark	14	14	2.4	2.4
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	SB	SBT	8	13	98.9	100.3
			SBR	5		102.7	
		EB	EBT	6	6	0.3	0.3
		WB	WBT	7	7	62.3	62.3

ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	EB	EBT	6	6	37.2	37.2
		WB	WBT	12	12	3.0	3.0
201	12th Street and Eads Street (Signalized)	NB	NBT	10	10	19.4	19.4
		SB	SBT	1	1	5.9	5.9
204	15th Street and Eads Street (Signalized)	NB	NBL	4	9	44.9	39.3
			NBT	5		34.8	
		SB	SBL	7	8	38.1	36.9
			SBT	0		-	
			SBR	1		28.8	
			EBL	5		48.1	
		EB	EBR	2	7	18.3	39.6
205	15th Street and Bell Street (Unsignalized)	EB	EBR	0	0	-	-
		WB	WBT	5	5	8.1	8.1
			WBL	0		-	
206	15th Street and 14 Rd S (Clark Street) (Unsignalized)	WB	WBT	18	18	0.1	0.1
207	15th Street and Crystal Dr (Signalized)	NB	NBL	18	18	12.1	12.1
208	18th Street and Eads Street (Signalized)	NB	NBT	2	2	15.8	15.8
		SB	SBL	0	2	-	8.6
			SBT	2		8.6	
		WB	WBT	8	8	18.4	18.4

ID	Intersection	Approach	Movement	Vissim Throughput (vph)		Average Delay (sec/veh)	
209	18th Street and Bell Street (Signalized)	SB	SBL	13	21	33.7	34.9
			SBT	0		-	
			SBR	8		37.0	
		EB	EBT	7	7	31.5	31.5
210	18th Street and Crystal Dr (Signalized)	NB	NBT	13	13	6.4	6.4
		EB	EBL	5	18	32.1	19.1
			EBR	13		14.1	
211	20th Street and Eads Street (Signalized)	NB	NBT	2	2	23.3	23.3
		SB	SBT	2	2	13.5	13.5
212	20th Street and Bell Street (Unsignalized)	SB	SBR	8	8	19.2	19.2
		WB	WBT	6	6	22.1	22.1
213	20th Street and Crystal Dr (Signalized)	NB	NBT	13	13	16.6	16.6
		SB	SBT	7	13	20.3	31.6
			SBR	6		44.9	
214	23rd Street and Eads Street (Signalized)	SB	SBR	2	2	21.8	21.8
		EB	EBL	2	8	30.5	28.2
			EBT	6		27.5	
		WB	WBT	6	13	30.5	16.7
			WBR	7		4.9	
215	23rd Street and Crystal Drive (Signalized)	NB	NBT	7	7	40.8	40.8
		SB	SBR	7	7	45.5	45.5
		EB	EBL	6	6	17.5	17.5

Transit Travel Time

PM Peak Period:



Transit Route	Average VISSIM
	(MM:SS)
10A NB (Alexandria-Pentagon)(WMATA)	04:48
10A SB (Alexandria-Pentagon)(WMATA)	05:21
23B EB (McLean-Crystal City)(WMATA)	08:42
23B WB (McLean-Crystal City)(WMATA)	07:55
Art 43 (Crystal City - Courthouse)(ART)	10:31
MW1 NB (Metroway-Potomac Yard)(WMATA)	05:39
MW1 SB Metroway-Potomac Yard)(WMATA)	08:20
599 PM WB (Pentagon - Crystal City Express)(Fairfax)	07:39
L-200 PM (Lake Ridge-Pentagon & Crystal City Express)(OmniRide)	08:15
7F SB (Lincolnia - North Fairlington)(WMATA)	02:31
23A EB (McLean - Crystal City)(WMATA)	06:04
23A WB (McLean - Crystal City)(WMATA)	07:11
22A EB (Barcroft - South Fairlington)(WMATA)	02:00
22A WB (Barcroft - South Fairlington)(WMATA)	01:37
7A NB (Lincolnia - North Fairlington)(WMATA)	01:45
7F NB (Lincolnia - North Fairlington)(WMATA)	01:34
682 (East Gate via Dulles South)(LC)	09:43
882 (Leesburg via Dulles North)(LC)	08:59



Appendix D-4

Vissim

Pedestrian Operations

Results

Pedestrian Intersection Performance

AM Peak Hour



*Results show the average from 10 simulation runs.

ID	Intersection	Approach	Movement	Vissim Throughput (pph)		Average Delay (sec/ped)		Level of Service
101	15th Street and Route 1 Southbound Ramp (Signalized)	North Leg	EB	14	28	3.8	4.4	A
			WB	14		5.0		
		South Leg	EB	10	20	21.6	21.8	C
			WB	10		22.1		
		East Leg	NB	0	0	-	-	-
			SB	0		-		
		West Leg	NB	1	2	128.5	128.5	F
			SB	1		128.5		
102	15th Street and Route 1 Northbound Ramp (Signalized)	North Leg	EB	17	34	25.8	27.5	C
			WB	17		29.3		
		South Leg	EB	39	78	4.6	4.8	A
			WB	39		5.0		
		East Leg	NB	24	47	127.7	123.5	F
			SB	23		119.1		
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	North Leg	EB	14	28	266.6	260.9	F
			WB	14		255.3		
		East Leg	NB	37	74	70.3	53.1	D
			SB	37		35.8		
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	South Leg	EB	3	6	87.4	70.8	E
			WB	3		54.3		
		West Leg	NB	38	75	88.3	61.9	E
			SB	37		34.9		
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	North Leg	EB	70	140	56.7	57.7	E
			WB	70		58.7		
		South Leg	EB	49	99	115.9	88.2	F
			WB	50		61.1		
		East Leg	NB	51	102	191.5	189.5	F
			SB	51		187.4		
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	North Leg	EB	23	46	185.3	127.2	F
			WB	23		69.1		
		South Leg	EB	50	99	113.6	118.8	F
			WB	49		124.1		
		East Leg	NB	7	13	193.1	184.4	F
			SB	6		174.3		
		West Leg	NB	6	12	59.4	51.9	D
			SB	6		44.4		

PM Peak Hour



ID	Intersection	Approach	Movement	Vissim Throughput (pph)		Average Delay (sec/ped)		Level of Service
101	15th Street and Route 1 Southbound Ramp (Signalized)	North Leg	EB	26	52	42.9	43.5	D
			WB	26		44.1		
		South Leg	EB	23	46	31.3	30.1	C
			WB	23		28.9		
		East Leg	NB	0	0	-	-	-
			SB	0		-		
		West Leg	NB	0	0	-	-	-
			SB	0		-		
102	15th Street and Route 1 Northbound Ramp (Signalized)	North Leg	EB	28	56	31.5	30.8	C
			WB	28		30.0		
		South Leg	EB	0	41	-	4.8	A
			WB	41		4.8		
		East Leg	NB	21	42	119.2	115.6	F
			SB	21		112.0		
103N	20th Street and Route 1/Clark Street (Signalized) (Northern Portion)	North Leg	EB	11	22	186.1	186.6	F
			WB	11		187.0		
		East Leg	NB	*	*	*	*	*
			SB	*		*		
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	South Leg	EB	5	10	125.4	114.0	F
			WB	5		102.7		
		West Leg	NB	*	*	*	*	*
			SB	*		*		
104E	23th Street and Route 1/Clark Street (Signalized) (Eastern Portion)	North Leg	EB	48	96	100.8	80.8	F
			WB	48		60.8		
		South Leg	EB	77	155	115.4	86.2	F
			WB	78		57.4		
		East Leg	NB	62	125	180.9	179.1	F
			SB	63		177.4		
104W	23rd Street and Route 1/Clark Street (Signalized) (Western Portion)	North Leg	EB	48	96	58.7	89.5	F
			WB	48		120.3		
		South Leg	EB	77	154	184.3	213.0	F
			WB	77		241.7		
		East Leg	NB	6	12	175.7	214.9	F
			SB	6		254.2		
		West Leg	NB	10	20	47.8	47.8	D
			SB	10		47.7		
*VISSIM Node Output Error								



Appendix D-5

Vissim

Bicycle Operations

Results

Bicycle Intersection Performance



AM Peak Hour

**Results show the average from 10 simulation runs.*

ID	Intersection	Approach	Movement	Vissim Throughput (bph)		Average Delay (sec/bike)		LOS*
101	15th Street and Route 1 Southbound Ramp (Signalized)	South Leg	EB	3	3	28.2	28.2	C
102	15th Street and Route 1 Northbound Ramp (Signalized)	South Leg	EB	3	3	0.0	0.0	A
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	East Leg	SB	37	37	2.1	2.1	A

Travel Time | Segment-by-Segment



AM Peak Period:

Bicycle Travel Time		
Segment ID	Route	Average VISSIM
		(MM:SS)
2000	15th St EB from Eads St to Bell St	01:55
2001	15th St WB from Bell St to Eads St	01:02
2002	18th St EB from Eads St to Bell St	01:51
2003	18th St WB from Bell St to Eads St	01:26
*Results show the average from 10 simulation runs.		

Bicycle Intersection Performance



PM Peak Hour

**Results show the average from 10 simulation runs.*

ID	Intersection	Approach	Movement	Vissim Throughput (bph)		Average Delay (sec/bike)	
101	15th Street and Route 1 Southbound Ramp (Signalized)	South Leg	EB	5	5	22.2	22.2
102	15th Street and Route 1 Northbound Ramp (Signalized)	South Leg	EB	5	5	0.0	0.0
103S	20th Street and Route 1/Clark Street (Signalized) (Southern Portion)	East Leg	SB	15	15	0.9	0.9

Travel Time | Segment-by-Segment



PM Peak Period:

Bicycle Travel Time		
Segment ID	Route	Average VISSIM
		(MM:SS)
305	15th St EB from Eads St to Bell St	01:57
2001	15th St WB from Bell St to Eads St	01:04
308	18th St EB from Eads St to Bell St	01:27
307	18th St WB from Bell St to Eads St	01:55
*Results show the average from 10 simulation runs.		



Appendix E

Historical Crash Analysis

Route 1 - Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

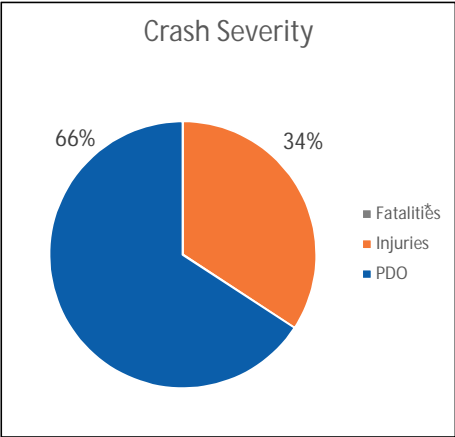
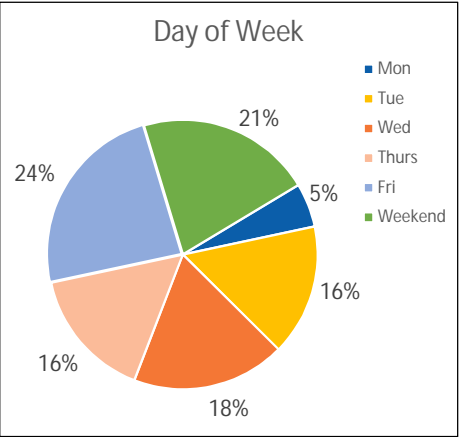
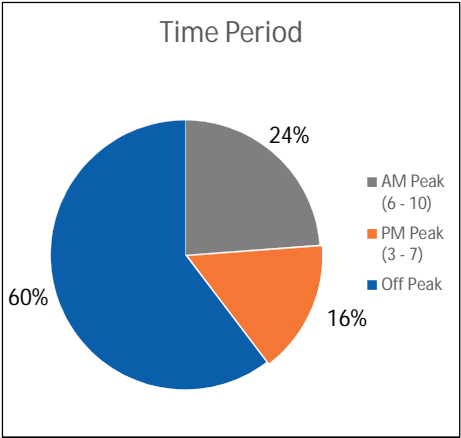
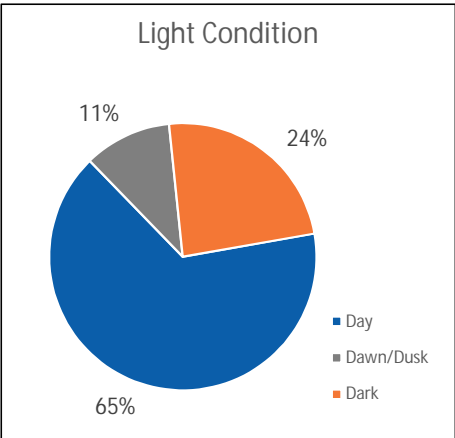
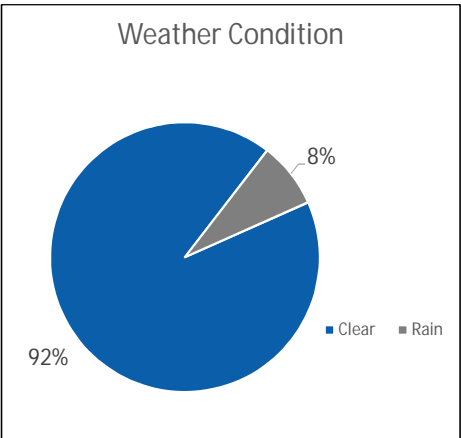
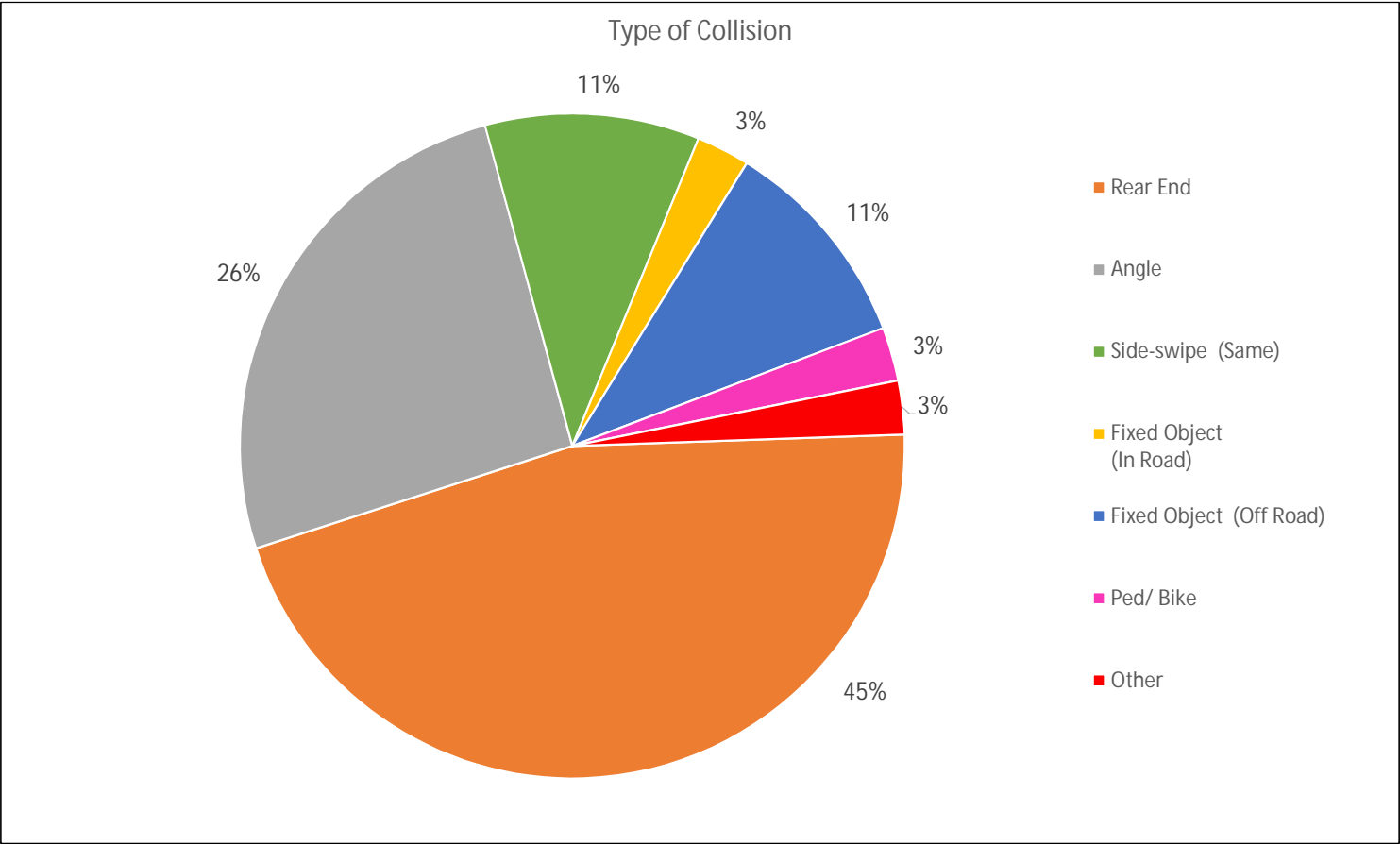
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain or Mist	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	4	9	1	3	1	4	1	3	0	1	12	9	1	3	12	1	4	2	3	0	2	1	1	13
2016	0	5	7	0	1	4	0	4	3	5	2	5	9	1	2	10	2	5	4	1	1	1	0	0	12
2017	0	2	1	0	0	1	0	2	0	0	2	1	2	0	1	3	0	3	0	0	0	0	0	0	3
2018	0	1	5	0	0	1	2	2	1	3	0	3	3	1	2	6	0	4	2	0	0	0	0	0	6
2019	0	0	3	1	1	0	0	0	1	1	0	2	2	0	1	3	0	1	1	0	0	1	0	0	3
2020	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	1
TOTAL	0	13	25	2	6	7	6	9	8	9	6	23	25	4	9	35	3	18	9	4	1	4	1	1	38

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0%	31%	69%	8%	23%	8%	31%	8%	23%	0%	8%	92%	69%	8%	23%	92%	8%	31%	15%	23%	0%	15%	8%	8%	34%
2016	0%	42%	58%	0%	8%	33%	0%	33%	25%	42%	17%	42%	75%	8%	17%	83%	17%	42%	33%	8%	8%	8%	0%	0%	32%
2017	0%	67%	33%	0%	0%	33%	0%	67%	0%	0%	67%	33%	67%	0%	33%	100%	0%	100%	0%	0%	0%	0%	0%	0%	8%
2018	0%	17%	83%	0%	0%	17%	33%	33%	17%	50%	0%	50%	50%	17%	33%	100%	0%	67%	33%	0%	0%	0%	0%	0%	16%
2019	0%	0%	100%	33%	33%	0%	0%	0%	33%	33%	0%	67%	67%	0%	33%	100%	0%	33%	33%	0%	0%	33%	0%	0%	8%
2020	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	3%
TOTAL	0%	34%	66%	5%	16%	18%	16%	24%	21%	24%	16%	60%	65%	11%	24%	92%	8%	46%	26%	11%	3%	11%	3%	3%	100%

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 Northbound Direction - Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

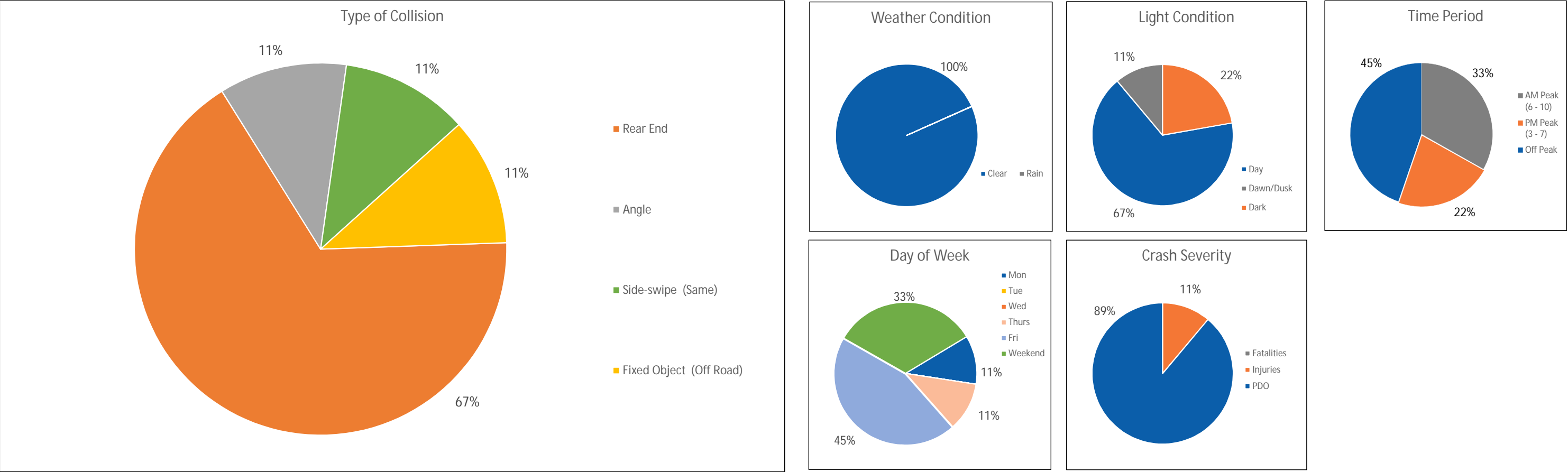
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain or Mist	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	0	4	1	0	0	1	1	1	0	1	3	2	0	2	4	0	2	1	1	0	0	0	0	4
2016	0	1	1	0	0	0	0	1	1	0	1	1	2	0	0	2	0	1	0	0	0	1	0	0	2
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	2	0	0	0	0	2	0	2	0	0	1	1	0	2	0	2	0	0	0	0	0	0	2
2019	0	0	1	0	0	0	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	1	8	1	0	0	1	4	3	3	2	4	6	1	2	9	0	6	1	1	0	1	0	0	9

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0%	0%	100%	25%	0%	0%	25%	25%	25%	0%	25%	75%	50%	0%	50%	100%	0%	50%	25%	25%	0%	0%	0%	0%	44%
2016	0%	50%	50%	0%	0%	0%	0%	50%	50%	0%	50%	50%	100%	0%	0%	100%	0%	50%	0%	0%	0%	50%	0%	0%	22%
2017	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2018	0%	0%	100%	0%	0%	0%	0%	100%	0%	100%	0%	0%	50%	50%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	22%
2019	0%	0%	100%	0%	0%	0%	0%	0%	100%	100%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	11%
2020	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL	0%	11%	89%	11%	0%	0%	11%	45%	33%	33%	22%	45%	67%	11%	22%	100%	0%	67%	11%	11%	0%	11%	0%	0%	100%

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 Southbound Direction - Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

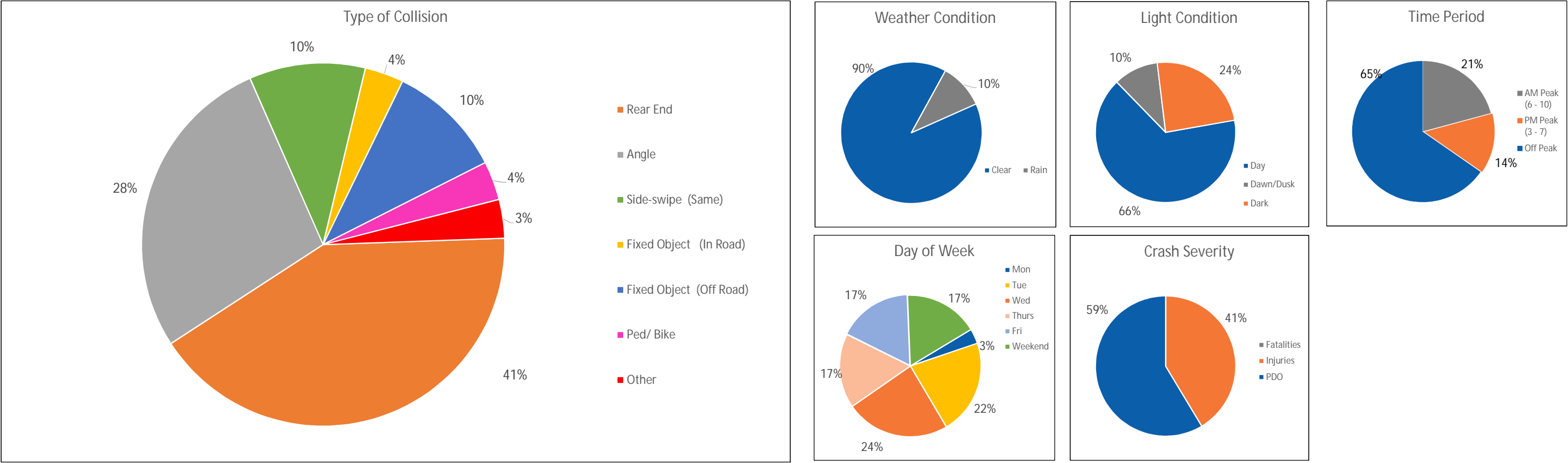
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain or Mist	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other		
2015	0	4	5	0	3	1	3	0	2	0	0	9	7	1	1	8	1	2	1	2	0	2	1	1	9	
2016	0	4	6	0	1	4	0	3	2	5	1	4	7	1	2	8	2	4	4	1	1	0	0	0	10	
2017	0	2	1	0	0	1	0	2	0	0	2	1	2	0	1	3	0	3	0	0	0	0	0	0	3	
2018	0	1	3	0	0	1	2	0	1	1	0	3	2	0	2	4	0	2	2	0	0	0	0	0	4	
2019	0	0	2	1	1	0	0	0	0	0	0	2	1	0	1	2	0	0	1	0	0	1	0	0	2	
2020	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	1	
TOTAL	0	12	17	1	6	7	5	5	5	6	4	19	19	3	7	26	3	12	8	3	1	3	1	1	29	

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other		
2015	0%	44%	56%	0%	33%	11%	33%	0%	22%	0%	0%	100%	78%	11%	11%	89%	11%	22%	11%	22%	0%	22%	11%	11%	31%	
2016	0%	40%	60%	0%	10%	40%	0%	30%	20%	50%	10%	40%	70%	10%	20%	80%	20%	40%	40%	10%	10%	0%	0%	0%	34%	
2017	0%	67%	33%	0%	0%	33%	0%	67%	0%	0%	67%	33%	67%	0%	33%	100%	0%	100%	0%	0%	0%	0%	0%	0%	10%	
2018	0%	25%	75%	0%	0%	25%	50%	0%	25%	25%	0%	75%	50%	0%	50%	100%	0%	50%	50%	0%	0%	0%	0%	0%	14%	
2019	0%	0%	100%	50%	50%	0%	0%	0%	0%	0%	0%	100%	50%	0%	50%	100%	0%	0%	50%	0%	0%	50%	0%	0%	7%	
2020	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	0%	0%	0%	0%	3%	
TOTAL	0%	41%	59%	3%	22%	24%	17%	17%	17%	21%	14%	65%	66%	10%	24%	90%	10%	42%	29%	10%	3%	10%	3%	3%	100%	

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 / Richmond Highway and 15th Street S (West) Intersection Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

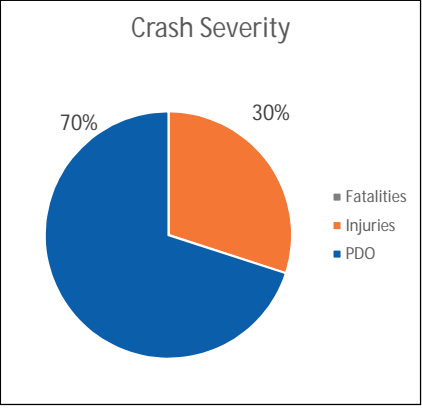
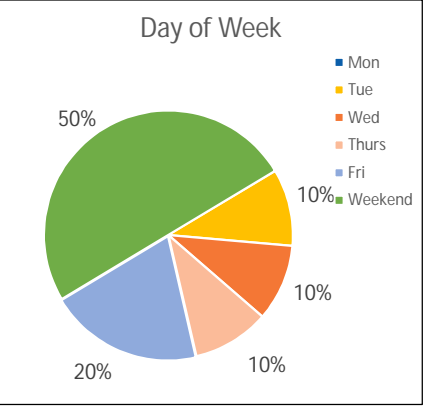
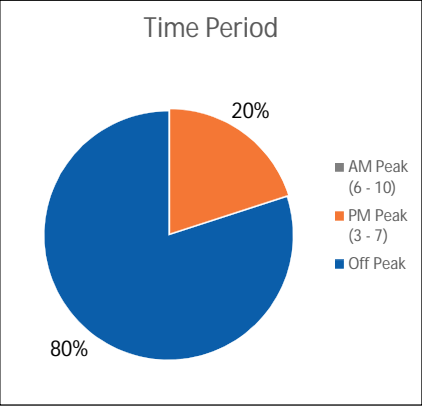
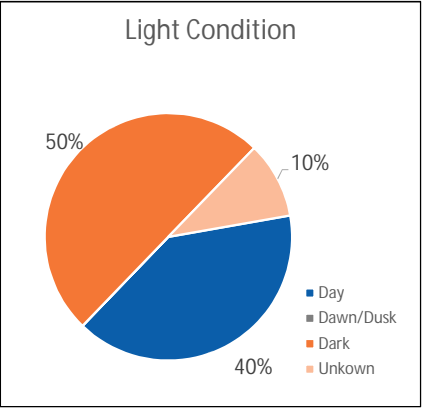
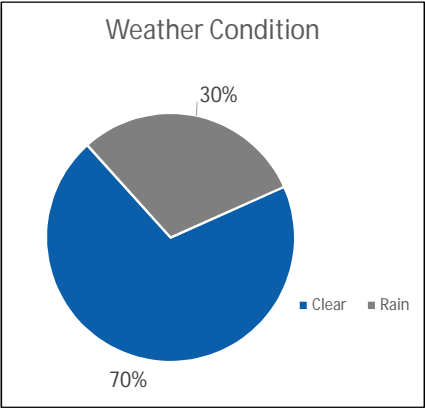
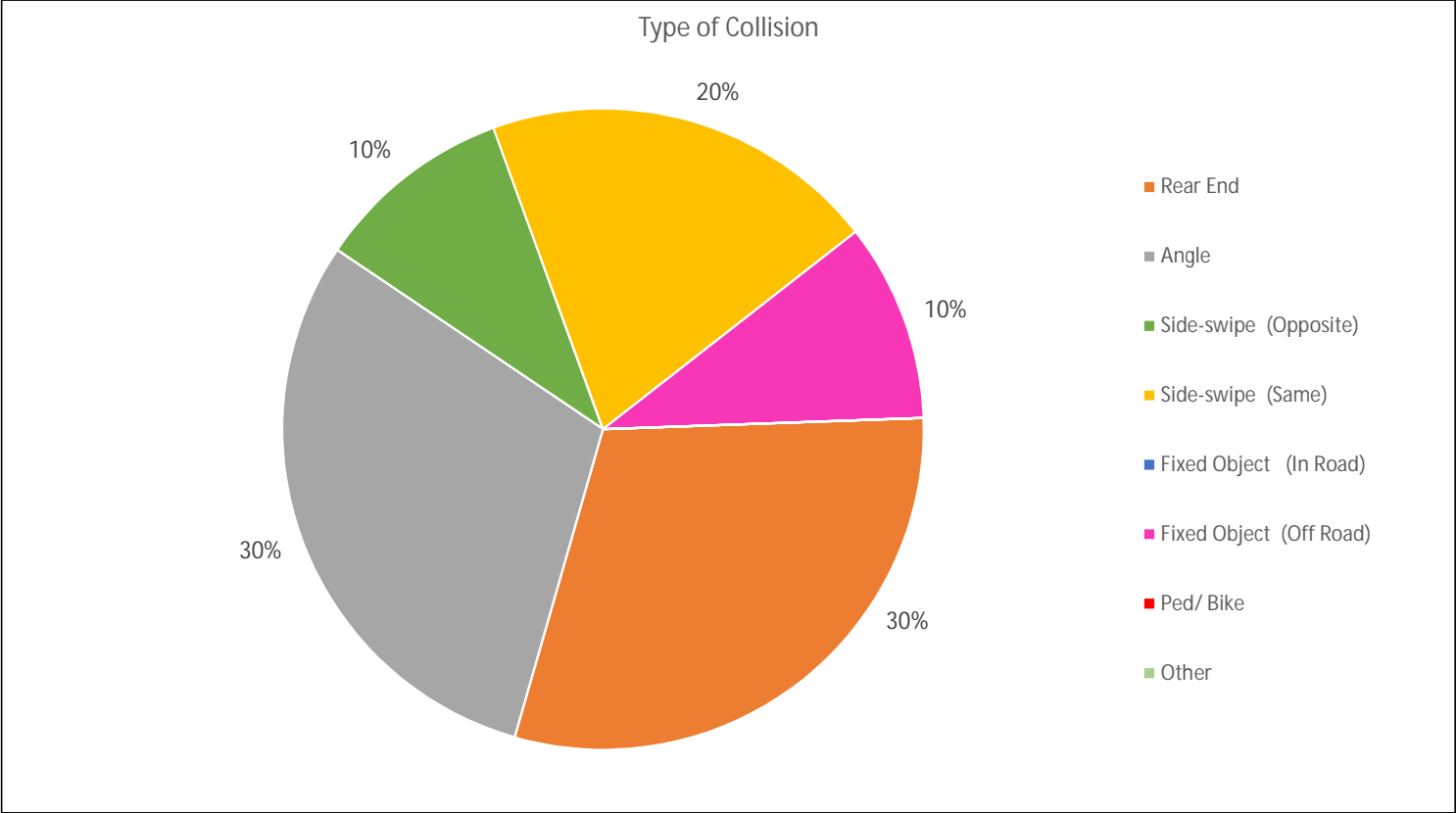
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION		TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain or Mist	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	1	3	0	0	0	1	1	2	0	1	3	2	0	2	0	2	2	2	1	0	1	0	0	0	0	4
2016	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	1	
2017	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	1	
2018	0	1	1	0	0	0	0	0	2	0	0	2	1	0	1	0	1	1	1	1	0	0	0	0	0	2	
2019	0	0	2	0	0	0	0	1	1	0	1	1	1	0	0	1	2	0	0	1	1	0	0	0	0	2	
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	0	3	7	0	1	1	1	2	5	0	2	8	4	0	5	1	7	3	3	3	1	2	0	1	0	0	10

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION		TYPE OF COLLISION										TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other			
2015	0%	25%	75%	0%	0%	0%	25%	25%	50%	0%	25%	75%	50%	0%	50%	0%	50%	50%	50%	25%	0%	25%	0%	0%	0%	0%	40%		
2016	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%	10%		
2017	0%	100%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	10%		
2018	0%	50%	50%	0%	0%	0%	0%	0%	100%	0%	0%	100%	50%	0%	50%	0%	50%	50%	50%	50%	0%	0%	0%	0%	0%	0%	20%		
2019	0%	0%	100%	0%	0%	0%	0%	50%	50%	0%	50%	50%	50%	0%	0%	50%	100%	0%	0%	50%	0%	0%	0%	0%	0%	0%	20%		
2020	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
TOTAL	0%	30%	70%	0%	10%	10%	10%	20%	50%	0%	20%	80%	40%	0%	50%	10%	70%	30%	30%	30%	10%	20%	0%	10%	0%	0%	100%		

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 / Richmond Highway and 15th Street S (East) Intersection Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

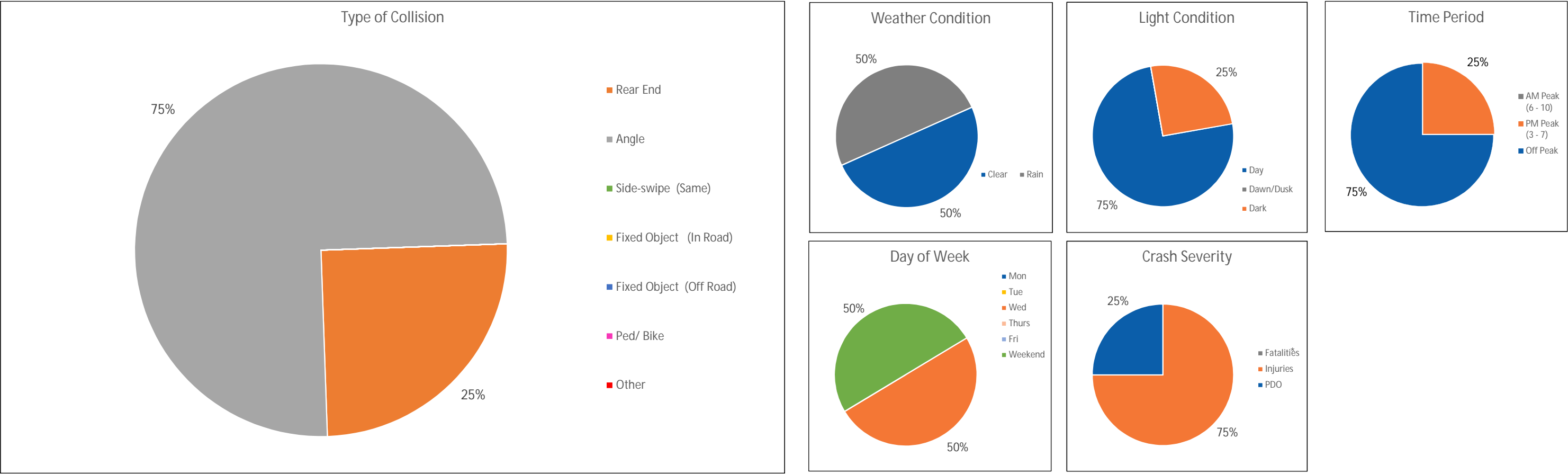
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain or Mist	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2016	0	3	1	0	0	2	0	0	2	0	1	3	3	0	1	2	2	1	3	0	0	0	0	0	4
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	0	3	1	0	0	2	0	0	2	0	1	3	3	0	1	2	2	1	3	0	0	0	0	0	4

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION			WEATHER CONDITION		TYPE OF COLLISION							TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Clear	Rain	Rear End	Angle	Side-swipe (Same)	Fixed Object (In Road)	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2016	0%	75%	25%	0%	0%	50%	0%	0%	50%	0%	25%	75%	75%	0%	25%	50%	50%	25%	75%	0%	0%	0%	0%	0%	100%
2017	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2018	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2019	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2020	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL	0%	75%	25%	0%	0%	50%	0%	0%	50%	0%	25%	75%	75%	0%	25%	50%	50%	25%	75%	0%	0%	0%	0%	0%	100%

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 / Richmond Highway and 20th Street S Intersection Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

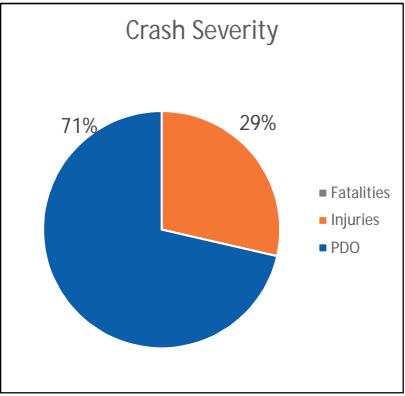
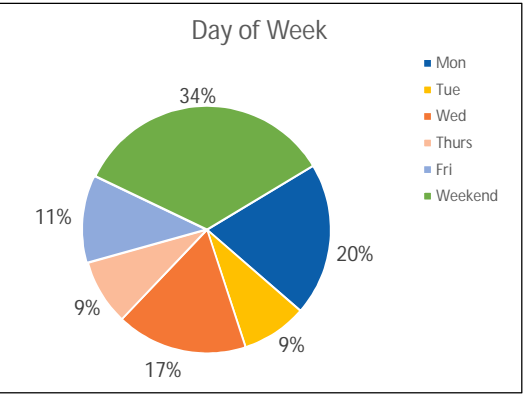
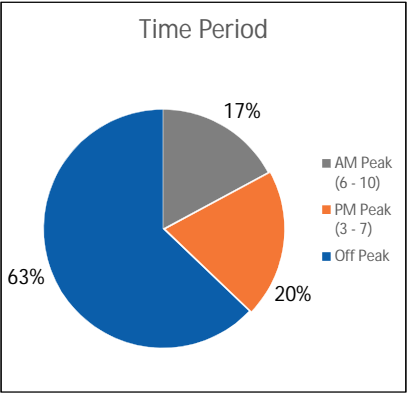
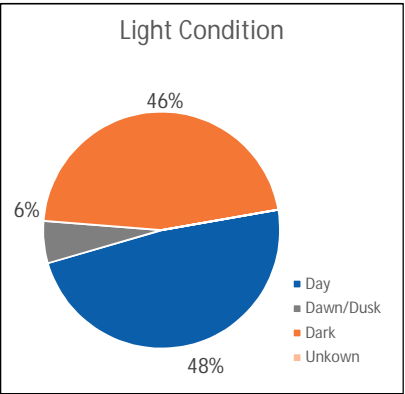
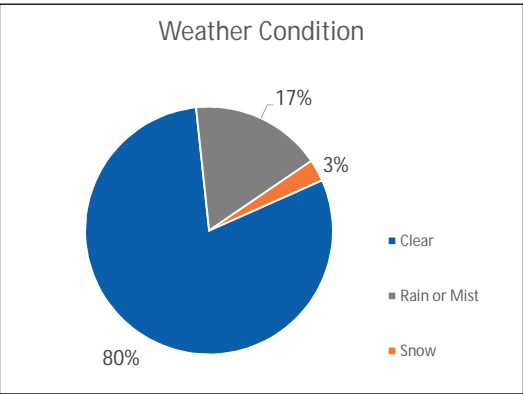
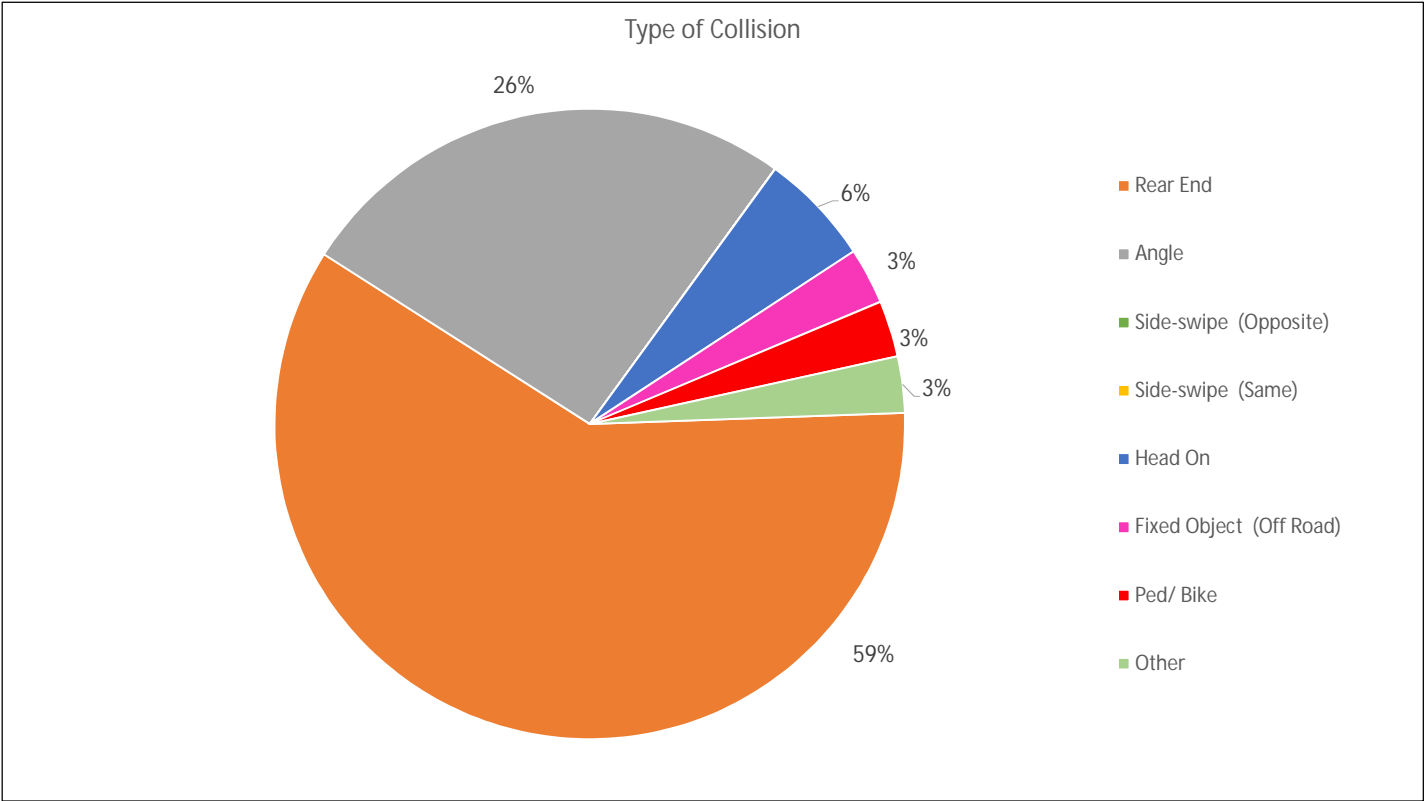
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION			TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain or Mist	Snow	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Head On	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	4	8	2	3	0	2	1	4	2	4	6	7	1	4	0	10	1	1	8	2	0	0	1	0	1	0	12
2016	0	3	5	2	0	1	0	2	3	1	2	5	4	1	3	0	5	3	0	4	2		0	1	1	0	0	8
2017	0	1	5	2	0	2	0	0	2	2	0	4	2	0	4	0	6	0	0	4	1		0	0	0	0	1	6
2018	0	1	4	1	0	2	0	1	1	0	1	4	2	0	3	0	4	1	0	2	3		0	0	0	0	0	5
2019	0	1	3	0	0	1	1	0	2	1	0	3	2	0	2	0	3	1	0	3	1		0	0	0	0	0	4
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
TOTAL	0	10	25	7	3	6	3	4	12	6	7	22	17	2	16	0	28	6	1	21	9	0	0	2	1	1	1	35

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION			TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain or Mist	Snow	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Head On	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0%	33%	67%	17%	25%	0%	17%	8%	33%	17%	33%	50%	58%	8%	33%	0%	83%	8%	8%	67%	17%	0%	0%	8%	0%	8%	0%	34%
2016	0%	38%	63%	25%	0%	13%	0%	25%	38%	13%	25%	63%	50%	13%	38%	0%	63%	38%	0%	50%	25%	0%	0%	13%	13%	0%	17%	23%
2017	0%	17%	83%	33%	0%	33%	0%	0%	33%	33%	0%	67%	33%	0%	67%	0%	100%	0%	0%	67%	17%	0%	0%	0%	0%	0%	17%	17%
2018	0%	20%	80%	20%	0%	40%	0%	20%	20%	0%	20%	80%	40%	0%	60%	0%	80%	20%	0%	40%	60%	0%	0%	0%	0%	0%	0%	14%
2019	0%	25%	75%	0%	0%	25%	25%	0%	50%	25%	0%	75%	50%	0%	50%	0%	75%	25%	0%	75%	25%	0%	0%	0%	0%	0%	0%	11%
2020	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL	0%	29%	71%	20%	9%	17%	9%	11%	34%	17%	20%	63%	48%	6%	46%	0%	80%	17%	3%	59%	26%	0%	0%	6%	3%	3%	3%	100%

Note: Crashes data for 2020 was only available up to February 28, 2020



Route 1 / Richmond Highway and 23rd Street S Intersection Crash Analysis
Crash Dates: January 1, 2015 to February 28, 2020

Total Comparison

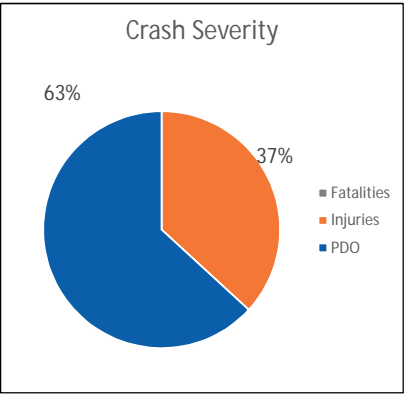
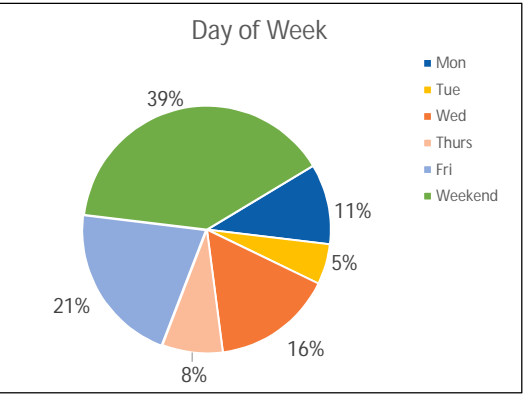
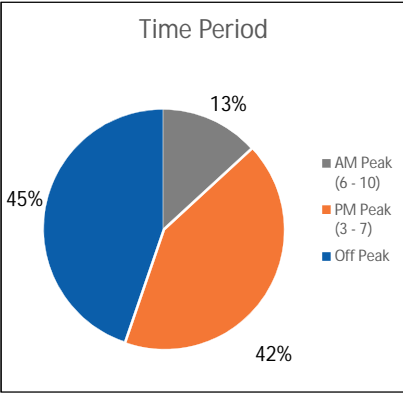
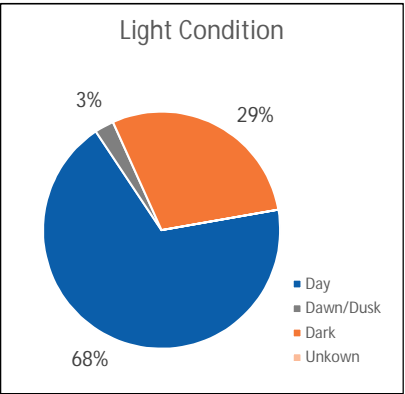
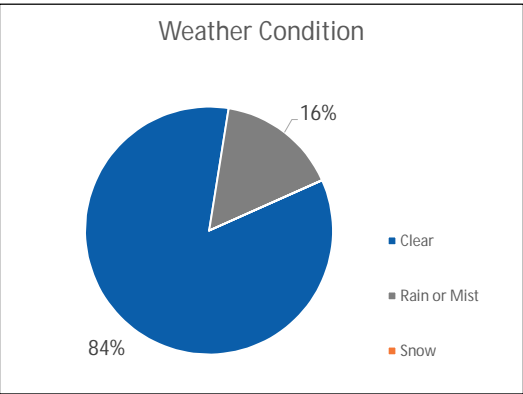
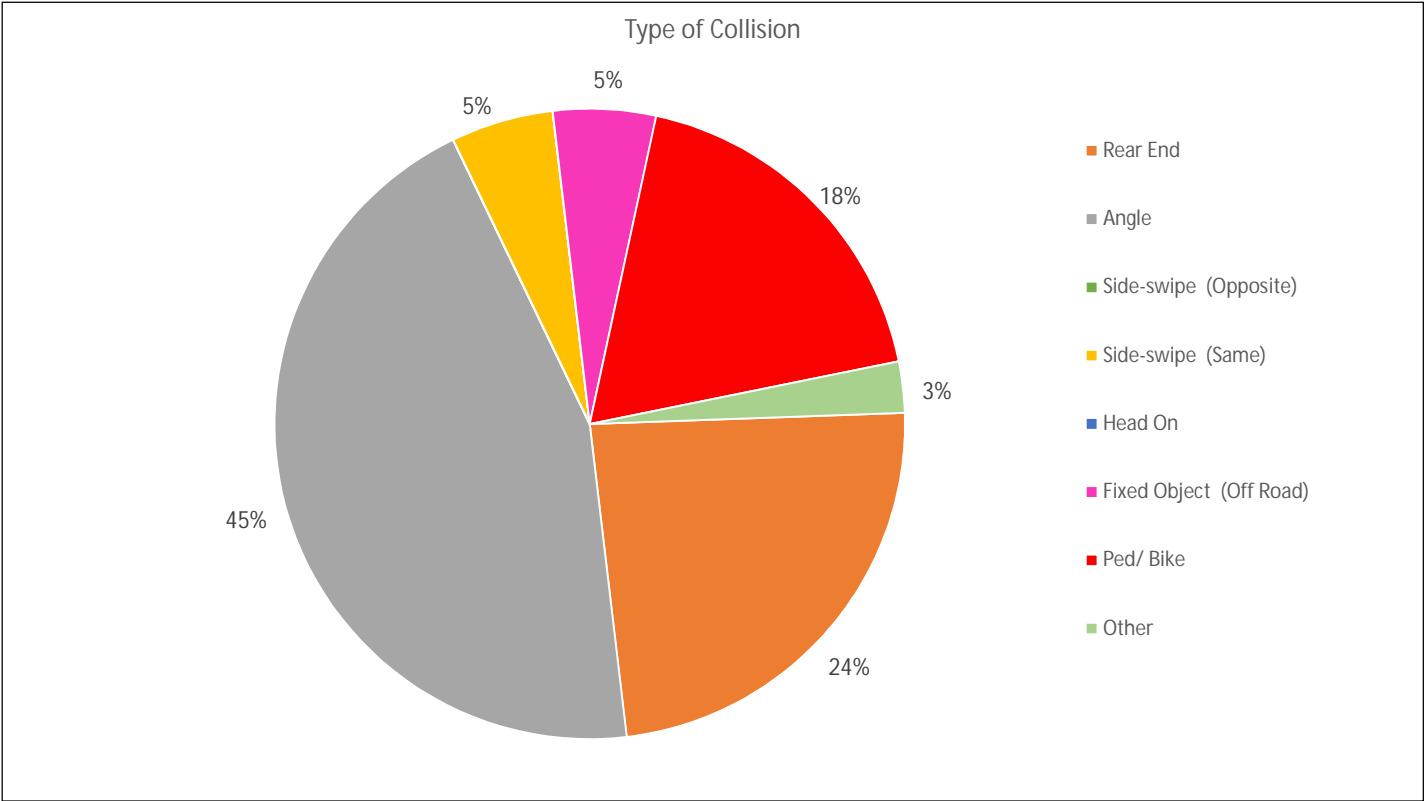
YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION			TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain or Mist	Snow	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Head On	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0	1	5	1	1	1	0	1	2	0	3	3	4	0	2	0	6	0	0	4	0	0	0	0	1	1	0	6
2016	0	2	5	0	1	1	1	1	3	1	2	4	4	1	2	0	6	1	0	0	4		1	0	1	1	0	7
2017	0	2	4	2	0	0	0	1	3	0	3	3	5	0	1	0	6	0	0	1	3		0	0	0	1	1	6
2018	0	4	5	0	0	2	1	2	4	0	6	3	5	0	4	0	5	4	0	3	3		0	0	0	3	0	9
2019	0	4	4	1	0	1	1	3	2	4	2	2	7	0	1	0	8	0	0	1	6		1	0	0	0	0	8
2020	0	1	1	0	0	1	0	0	1	0	0	2	1	0	1	0	1	1	0	0	1		0	0	1	0	0	2
TOTAL	0	14	24	4	2	6	3	8	15	5	16	17	26	1	11	0	32	6	0	9	17	0	2	0	2	7	1	38

Note: Crashes data for 2020 was only available up to February 28, 2020

Percentage Comparison

YEAR	SEVERITY			WEEKDAY					WEEKEND	TIME PERIOD			LIGHT CONDITION				WEATHER CONDITION			TYPE OF COLLISION								TOTAL
	Fatalities	Injuries	PDO	Mon	Tue	Wed	Thurs	Fri	Weekend	AM Peak (6 - 10)	PM Peak (3 - 7)	Off Peak	Day	Dawn/ Dusk	Dark	Other	Clear	Rain or Mist	Snow	Rear End	Angle	Side-swipe (Opposite)	Side-swipe (Same)	Head On	Fixed Object (Off Road)	Ped/ Bike	Other	
2015	0%	17%	83%	17%	17%	17%	0%	17%	33%	0%	50%	50%	67%	0%	33%	0%	100%	0%	0%	67%	0%	0%	0%	0%	17%	17%	0%	16%
2016	0%	29%	71%	0%	14%	14%	14%	14%	43%	14%	29%	57%	57%	14%	29%	0%	86%	14%	0%	0%	57%	0%	14%	0%	14%	14%	0%	18%
2017	0%	33%	67%	33%	0%	0%	0%	17%	50%	0%	50%	50%	83%	0%	17%	0%	100%	0%	0%	17%	50%	0%	0%	0%	0%	17%	0%	16%
2018	0%	44%	56%	0%	0%	22%	11%	22%	44%	0%	67%	33%	56%	0%	44%	0%	56%	44%	0%	33%	33%	0%	0%	0%	0%	33%	0%	24%
2019	0%	50%	50%	13%	0%	13%	13%	38%	25%	50%	25%	25%	88%	0%	13%	0%	100%	0%	0%	13%	75%	0%	13%	0%	0%	0%	0%	21%
2020	0%	50%	50%	0%	0%	50%	0%	0%	50%	0%	0%	100%	50%	0%	50%	0%	50%	50%	0%	0%	50%	0%	0%	0%	50%	0%	0%	5%
TOTAL	0%	37%	63%	11%	5%	16%	8%	21%	39%	13%	42%	45%	68%	3%	29%	0%	84%	16%	0%	24%	45%	0%	5%	0%	5%	18%	3%	100%

Note: Crashes data for 2020 was only available up to February 28, 2020





Appendix F

Existing Structures

Memo

Memo

Date: Wednesday, November 11, 2020

Project: Route 1 Multimodal Improvements – VDOT Northern Virginia District

To: R. John Martin, P.E., Kimley-Horn

From: Nancy Connor, PE

Subject: Existing Conditions Memo - Structures

1.0 Structures on Route 1

Structural Overview

This report identifies and summarizes the conditions of the existing structures on and adjacent to Route 1 as part of the Route 1 Multimodal Improvements project in the Crystal City area of the City of Arlington, Virginia in VDOT's Northern Virginia District. The portion of roadway considered in this report stretches from the Route 1 intersection with 23rd Street at the south end through the Route 1 overpass over 12th Street at the north end.

Three main structures existing along this corridor: A bridge carrying Route 1 over 18th Street; a bridge carrying Route 1 over 15th Street; and a bridge carrying Route 1 over 12th Street. Each bridge has wingwalls and extended retaining walls that will need to be considered as this project advances. Table 1 at the bottom of this report summarizes the existing conditions of each structure.

Route 1 over 18th Street

The Route 1 bridge over 18th Street is a two-span steel structure that carries both northbound and southbound traffic as well as an on and off ramp for Route 1 traffic coming to and from 15th Street. This structure is in good condition with both the deck and substructure having ratings of 6 while the superstructure has a rating of 7. The structure is composed of two independent bridges with a longitudinal joint between northbound and southbound traffic. The existing vertical clearance over 18th Street is 14'-1", which is less than the current regulations.

The abutments of this bridge are composed of retaining walls that support approach fill on both the north and south ends of the bridge. The walls extend to the east where they also supported a bridge superstructure in the past that was demolished as part of a previous project.

If this bridge is demolished as part of the improvements project, additional analysis will need to be performed for existing buildings at all corners of the bridge except the northeast corner. Retained fill is in place against the first-floor walls at these corners and an investigation will need to be performed to ensure the building foundations in these locations are deep enough to avoid being exposed. Additional architectural work may also be required.

If the bridge remains in place, repair measures should be taken following recommendations in the most recent inspection reports. Examples of needed repairs are clearing trees that block the low clearance signs, repairing concrete spalls and delaminations on some areas of the bridge, and repairing bearing deficiencies at the pier.

A temporary retaining structure may be required to support the existing fill during maintenance of traffic operations.

Attached Retaining Walls

An MSE retaining wall is extended off of the northeast wingwall for a length of approximately 150ft. The retaining wall is in good condition; if the wall is maintained and any work needs to occur behind the wall, it will need to take place approximately 15 – 20ft from the wall to avoid the earth stabilizing straps attached to the wall.

Route 1 over 15th Street

The Route 1 bridge over 15th Street is a two-span steel structure that carries both northbound and southbound traffic. This structure is in good condition with both the deck and substructure having ratings of 6 while the superstructure has a rating of 7. The structure is composed of two independent bridges with a longitudinal joint between northbound and southbound traffic. The existing vertical clearance over 15th Street is 16'-3", which is slightly less than the current regulations.

The abutments of this bridge are composed of retaining walls that support approach fill on both the north and south ends of the bridge. The wingwalls are turned back to run parallel with the roadway and the fill is sloped to on and off ramps on all four corners of the bridge as well as to 15th Street with short retaining walls in place to prevent fill from falling onto the ramps.

If the bridge remains in place, repair measures should be taken following recommendations in the most recent inspection reports. Examples of needed repairs are replacing expansion joints at abutments, replacing sheared anchor bolts at bearings, and repairing cracks in the top of abutment backwalls. Additionally, there are traffic signals on 15th Street adjacent to the bridge that do not appear to have foundation attachments that meet current standards and may need to be replaced.

Temporary retaining structures may be required to support existing fill during maintenance of traffic operations.

Associated Retaining Walls

Short retaining walls are present on the northwest, southeast, and southwest corners of the Route 1 and 15th Street intersection to prevent the slope coming down from Route 1 from extending onto the ramps at each corner. Each wall is an MSE wall with a maximum height of approximately 5ft. The northwest wall is approximately 250ft long; the southeast wall is approximately 225ft long; and the southwest wall is approximately 275ft long. The walls are in good condition and are not attached to the bridge structure. If the wall is maintained and any work needs to occur behind the wall, it will need to take place approximately 10-15ft behind the wall to avoid the earth stabilizing straps attached to the wall.

Route 1 over 12th Street

The Route 1 bridge over 12th Street is a single span steel structure that carries both northbound and southbound traffic as well as an on and off ramp on the west side of the structure from Route 110 to 15th Street, respectively. The structure is in good to fair condition with the deck having a rating of 7, the



superstructure having a rating of 6, and the substructure having a rating of 5. The structure is composed of two independent bridges with a longitudinal joint between northbound and southbound traffic. The existing vertical clearance over 12th Street is 17'-3".

The abutments of this bridge are composed of retaining walls that support approach fill on both the north and south ends of the bridge. The wingwalls are turned back to run parallel with the roadway and Route 1 remains elevated over the surrounding ground until its junction with I-395.

If the bridge is demolished as part of the improvements project, maintaining traffic while transitioning to an at-grade boulevard and maintain the junction with I-395 will be a critical consideration. Both Route 1 at the 15th Street intersection and the junction with I-395 are elevated with retaining walls restricting traditional widening measures taken during MOT operations.

If the bridge remains in place, repair measures should be taken following recommendations in the most recent inspection reports. Examples of needed repairs are securing or repairing anchor bolts in the railing posts, replacing expansion joints at Abutment B, and repairing concrete spalls, delaminations, and spalls at various locations throughout the bridge. Additionally, there are traffic signals on 12th Street adjacent to the bridge that do not appear to have foundation attachments that meet current standards and may need to be replaced.

Temporary retaining structures may be required to support existing fill during maintenance of traffic operations.

Attached Retaining Walls

Retaining walls extend beyond the wingwalls on all four corners. The retaining walls on the south end of the bridge are MSE walls and extend approximately 675ft on the southeast corner and 825ft on the southwest corner. Heavy vegetation is present on the southeast wall, but there does not appear to be any settlement in the approach fill and the walls appear to be in good condition. If the wall is maintained and any work needs to occur behind the wall, it will need to take place approximately 15 – 20ft from the wall to avoid the earth stabilizing straps attached to the wall. The retaining walls on the north end of the bridge are concrete walls and extend approximately 900ft on the northeast corner and approximately 325ft on the northwest corner. These walls are in good condition.

Summary of Existing Structures

Table 1 - Summary of Existing Structures			
Structure	Deck Rating	Superstructure Rating	Substructure Rating
Route 1 over 12 th Street	7	6	5
Route 1 over 15 th Street	6	7	6
Route 1 over 18 th Street	6	7	6

1. A rating of 5 indicates Fair Condition; 6 indicates Satisfactory Condition; 7 indicates Good Condition.
2. Associated wingwalls and retaining walls for each bridge are in generally good condition.



Appendix G

Existing Geotechnical Memo

Memo

Date: Wednesday, November 11, 2020

Project: Route 1 Multimodal Improvements – VDOT Northern Virginia District

To: R. John Martin, P.E., Kimley-Horn

From: Sunil Malla, PE; J. Michael Hall, PE

Subject: Existing Conditions Memo - Geotechnical

1.0 Project Information and Scope

This project consists of multimodal improvements along the Route 1 corridor between 12th Street at the north end and 23rd Street at the south end in Crystal City, Arlington, Virginia. The concept design project area is shown in Attachment 1. Within the project area, Route 1 consists of grade-separated intersections at 12th Street, 15th Street and 18th Street, and at-grade intersections at 20th Street and 23rd Street.

Multimodal transportation demand has been increasing due to the arrival of the Amazon US Headquarters (HQ2) and other on-going developments in the Crystal City/ Pentagon City area. The purpose of this project is to provide better multimodal connectivity and accommodation along and across Route 1 to meet the changing transportation needs of this growing urban activity center.

The Kimley-Horn kickoff meeting presentation slides dated July 29, 2020 illustrate the improvement plans, including the reconfiguration of the Route1 intersection at 20th Street and relocation of S. Clark and Bell Streets. The Google Earth imagery no longer shows S. Clark Street, and the S. Clark Street bridge over 18th Street has already been removed.

As a part of Phase I – Multimodal Transportation Analysis/ Feasibility Study, the objectives of this memo are to collect and review the available data and to discuss the expected subsurface conditions at the existing structures, pavements and embankment slopes along Route 1.

2.0 Available Data

As-built drawings for the existing features within the project area are not available at this time. Therefore, HDR predominantly used Google Earth imagery to identify existing major features along the project corridor that need to be considered for geotechnical analysis. To get a better understanding of the project features, HDR also reviewed boring location plans, wall elevation drawings, and boring logs obtained from VDOT. The boring location plans and wall elevation drawings are included in Attachment 2 and the boring logs in Attachment 3. A geology map showing the prominent geologic formations within the project area is also included in Attachment 3.

It should be noted that the information obtained from VDOT is dated September 5, 1985, and some of the features shown on the location plans no longer exist (e.g., S. Clark Street bridge over 18th Street and Retaining Walls 4, 10 and 11 along S. Clark Street). Attachment 2 is included with this memo to show the locations of the existing soil borings and to provide the locations of some of the existing retaining walls and bridges.

HDR also reviewed Mechanically-Stabilized Earth (MSE) wall typical section and elevation drawings of Retaining Walls 3, 5, 6, 7, 8, and 9, and they are included in Attachment 4. Two sets of drawings for each MSE wall were obtained from VDOT, one dated October 12, 1985 prepared by The Reinforced Earth Company (RECo) and the other dated August 15, 1985 prepared by VSL Corporation. It is our understanding that the contractor was permitted to select either of these two walls systems, and based on Google Earth imagery and MSE wall panel drawings shown in Attachment 4, the existing MSE walls appear to have been constructed using RECo's design.

3.0 Subsurface Summary

The following sections provide information on project area geology and a summary of the 1985 subsurface explorations completed at the project site. Specific observations, remarks, and comments are reflected on the boring logs provided in Attachment 3.

3.1 Project Area Geology

A geology map of the project area is included in Attachment 3. The project site is located near the eastern edge of the Coastal Plain Physiographic Province. The Coastal Plain Province consists of eastward-thickening wedge of unconsolidated river/deltaic and marine sediments. The interbedding of fine- and coarse-grained sediments is complex due to irregular deltaic and alluvial deposition, as well as cyclic marine deposition associated with transgressions and regressions of the sea. Strata unconformities (gaps in the geologic record) due to periods of erosion and regional faulting are common within the area. As a result, strata composition and thicknesses can vary greatly over short horizontal or vertical distances.

Artificial fill soils (af) are present throughout the project associated with the original construction of the roadway. The fill soils support the existing roadway grades where grade separations exist.

The area along Route 1 between 12th Street and 15th Street is underlain by Alluvial deposits (Qal). These soils often indicate a buried channel typically having a high groundwater table, weak soils, and occasionally iron oxide-cemented gravel. Sediments are well to poorly sorted with micaceous silt and sand.

The area between 15th Street and 23rd Street is underlain by Lowland Terrace deposits (Qt1 and Qt2). These deposits consist of gravel, sand, silt, and clay, and are present throughout the project site. The sands are gray, gray brown, and orange, fine to coarse-grained, poorly sorted, and commonly thick bedded. These estuarine deposits are related to sea level change during the ice ages while the uppermost deposits are river deltas and terraces. Drainage of these soils is typically poor, and water is commonly found at the surface because of low relief and proximity to the water table.

The area underlain by Potomac formation (Kpu) is located near the southern end of the project corridor and consists of sands, silts and clays. The quartzo-feldspathic sands are light gray to pinkish and greenish gray, fine to coarse-grained, poorly sorted, and commonly thick bedded. The sands are interbedded with gray to green, massive to thick-bedded clay and silt that is commonly mottled red or reddish brown. Low to highly plastic silts and clays of variable thicknesses underlie surface silts, sands, and gravels. The soils of the Potomac Formation occur on side slopes and hilltops, and within the older or buried floodplains of the Coastal Plain Physiographic Province. For the site area, this formation deposited mainly in fluvial-deltaic environments with thin glauconitic sands of shallow-shelf origin. The thickness ranges from feather-edge at western limit of outcrop to more than 3,500 feet in the subsurface of the outermost, eastern Coastal Plain.

The high-plasticity silt and clay deposits of the Potomac Formation (also referred to as marine clays or Potomac clays) are highly fractured and broken and contain fissures and discontinuities. They are considered "unsuitable" and are known locally to be problematic, specifically with regards to slope stability and volumetric changes with moisture variation (shrinking and swelling). High-plasticity Potomac formation clays can present stability issues over extended periods of time due to the potential for softening and weakening along the existing fissures in the clay, resulting from exposure of the fissures to disturbance and

water from construction activities. The clays often exhibit slickensides (previously sheared surfaces characterized by residual shear strengths) along the fissures and discontinuities that may impact their overall stability.

3.2 Subsurface Soil

Subsurface conditions vary along Route 1 and consist of sands, gravels, silts, and clays. HDR typically observed two strata throughout the alignment.

HDR observed Stratum I (Fill Soils) in majority of the borings included in this memo. Stratum I ranged in thickness from approximately 2 feet to 12 feet. Stratum I consists primarily of sands and sandy silts; however, gravels, silts, and clays were present to a lesser extent. The fill layer near the surface along Route 1 NB between 12th Street and 18th Street contains glass, wood, brick and concrete fragments and other debris

Stratum II (Native Coastal Plain Soils - Interbedded Sands and Clays) was observed below Stratum I, where present, and ranged in thickness from approximately 2 feet to 55 feet within the test boring depths. Stratum II soils consist of interbedded sands and clays; however, gravels and silts were present to a lesser extent.

Up to 8 feet of organic silt was identified near the surface, and soils mixed with organic matter to a depth of 15 feet were observed in the area between 12th Street and 15th Street along Route 1 SB within the alluvial deposits.

3.3 Subsurface Water

Subsurface water was observed in 17 of the borings as shown in Table 1. The water was observed at depths ranging from approximately 0 to 40.5 feet below ground surface. Refer to Table 1 and the exploration logs in Attachment 3 for specific observations of subsurface water at the exploration locations. Note that subsurface water levels tend to fluctuate due to precipitation, season, temperature, site grading, and other factors that may be different from those prevailing at the time of subsurface explorations.

Table 1. Summary of Subsurface Water Observations

1985 Borings	Boring Station	Boring Surface Elevation (ft)	Approximate Subsurface Water Depth (ft)	Approximate Subsurface Water Elevation (ft)
1	171+76	46.5	30.5	16
22	114+00	32.7	28.2	4.5
W-2	144+00	41.5	35.0	6.5
W-3	145+25	40.3	34.0	6.3
W-16	164+23	48.4	30.0	18.4
W-4-1	166+20	47.9	15.3	32.6
W6-2	169+00	46.2	31.5	14.7
W7-4	176+00	31.1	0	31.1
W7-3	183+00	34	17	17
W8-1	173+00	44.5	25.5	19
W8-2	174+00	40.5	40.5	0
W9-2	176+30	37.6	40.5	-2.9
W9-3	177+14	36.5	20.5	16
W-30	178+00	35.3	16	19.3
W-31	179+50	34.4	15	19.4
W-32	180+50	32.4	10	22.4
W9-7	181+00	32.4	15.5	17.4

4.0 Existing Features

4.1 Bridges

The project corridor consists of three bridges along Route 1 over 12th Street, 15th Street and 18th Street. Bridge plans are not available at this time; therefore, there is no information about the bridge foundations. The load-carrying capacity and structural integrity of the existing foundations will need to be evaluated for the new construction to determine whether the bridge must be replaced or can remain in place. Strengthening of the existing foundation elements may be required for the new traffic conditions, new design life, and the current bridge design standards applicable for the project area.

Route 1 Bridge over 12th Street

This bridge is a single-span steel structure that carries both northbound (NB) and southbound (SB) traffic. The structure is composed of two independent bridges with abutments consisting of wrap-around concrete retaining walls that retain the approach embankments fills. The nearest 1985 borings for this bridge are W-32-71 and W-9-7.

Route 1 Bridge over 15th Street

This bridge is a two-span steel structure that carries both NB and SB traffic. The structure is composed of two independent bridges with abutments and approach embankment fill slopes. The embankment slopes of the south abutments and west side of north abutment are retained by MSE retaining walls. The nearest 1985 borings for the south abutment of this bridge are W5-2, W5-3 and W6-2 and for the north abutment are Borings 1, 16, W-8-1 and W-24-71.

Route 1 Bridge over 18th Street

This is a two-span steel structure that carries both NB and SB traffic. The structure is composed of two independent bridges with abutments consisting of wrap-around concrete retaining walls that retain the approach embankments fills. The bridge abuts the Marriott Hotel building on the northwest side, the Westin Hotel building on the southwest side and 1800 S. Bell Street building on the southeast side. The nearest 1985 borings for this bridge are Borings 12 and W-16-71.

4.2 Retaining Walls

As shown in Attachments 2 and 4 and observed from Google Earth imagery, the project area consists of MSE Retaining Walls 3, 5, 6, 7, 8, and 9. The project area also consists of concrete retaining walls as indicated in Section 4.1. Retaining Walls 1, 2, 12 and 13 shown in Attachment 2 are located outside of the project area, and Retaining Walls 4, 10 and 11 along S. Clark Street no longer exist.

Retaining Wall 3

This is an MSE wall retaining the embankment fill of the S. Clark Street ramp (Ramp E). It abuts the east side wingwall near north abutment of the bridge over 18th Street. Although the S. Clark Street bridge has been removed, it is not known whether this wall will also be demolished or kept in place. If the wall remains in place, the geotechnical resistance of the wall foundation will have to be evaluated for the planned improvements.

The 1985 borings located along this wall are Borings 12, 13 and W-16-71. Based on RECo's drawing included in Attachment 4, the wall height varies from 2 to 22 feet with finished grade in front of the wall varying from Elevation 68 (EL68) to Elevation 50 (EL50). The wall starts at Ramp Station 10+00 and ends at Station 11+35. The 12-inch by 6-inch leveling pad elevation varies from EL65.72 to 48.5. The reinforced backfill behind the wall consists of granular fill material and 50 mm by 4 mm steel reinforcing strips. The length of reinforcing strips varies from 8 to 16 feet.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Retaining Wall 5

This is an MSE wall retaining the west side embankment slope at the south abutment of the bridge over 15th Street along Ramp A, the on-ramp from 15th Street to Route 1 SB. The 1985 borings located along this wall are Borings W5-1, W5-2, W5-3 and W-22-71.

As shown in Attachments 2 and 4, the wall height varies from 3 to 10 feet with finished grade in front of the wall varying from EL64 to EL48. The wall starts at Wall Station 16+73.50 and ends at Station 19+41.83. The 12-inch by 6-inch leveling pad elevation varies from EL61.38 to EL46.62. The reinforced backfill behind the wall consists of granular fill material and 50 mm by 4 mm steel reinforcing strips. The length of reinforcing strips is 10 feet. The design bearing pressure for this wall is indicated to be 1.5 tons per square feet on the plan and elevation drawing included in Attachment 2.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Retaining Wall 6

This is an MSE wall retaining along the east side embankment slope at the south abutment of the bridge over 15th Street along Ramp C, the off-ramp from Route 1 NB to 15th Street. The 1985 borings located along this wall are Borings W6-2 and W-20-71.

As shown in Attachments 2 and 4, the wall height varies from 3 to 9 feet with finished grade in front of the wall varying from EL57 to EL47. The wall starts at Wall Station 18+20.77 and ends at Station 20+39.34. The 12-inch by 6-inch leveling pad elevation varies from EL54.92 to EL45.08. The reinforced backfill behind the wall consists of granular fill material and 50 mm by 4 mm steel reinforcing strips. The length of reinforcing strips is 10 feet. The design bearing pressure for this wall is indicated to be 1.5 tons per square feet on the plan and elevation drawing included in Attachment 2.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Retaining Wall 7

This is an MSE wall that retains the embankment fill of Ramp B, the off-ramp from Route 1 SB to 15th Street. The 1985 borings located along this wall are Borings 2, 3, 4, 5, 6, and W7-4.

As shown in Attachments 2 and 4, the wall height varies from 2 to 25 feet with finished grade in front of the wall varying from EL48 to EL30. The wall starts at Wall Station 22+50 and ends at Wall Station 180+90.56. The 12-inch by 6-inch leveling pad elevation varies from EL46.00 to EL27.55. The reinforced backfill for the wall consists of granular fill material and 50 mm by 4 mm steel reinforcing strips. The length of reinforcing strips varies from 8 to 18 feet.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Retaining Wall 8

This is an MSE wall retaining the west side embankment slope at the north abutment of the bridge over 15th Street along Ramp B, the off-ramp from Route 1 SB to 15th Street. The 1985 borings located along this wall are Borings 1, W-8-1, W-8-2, W-24-71 and W-25-71.

As shown in Attachments 2 and 4, the wall height varies from 3 to 9 feet with finished grade in front of the wall varying from EL55 to EL47. The wall starts at Wall Station 21+32.74 and ends at Station 23+81.02. The 12-inch by 6-inch leveling pad elevation varies from EL52.92 to EL45.54. The reinforced backfill for the wall consists of granular fill material and 10-foot long, 50 mm by 4 mm steel reinforcing strips.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Retaining Wall 9

This is an MSE wall that retains the embankment fill of Ramp D, the on-ramp from 15th Street to Route 1 NB. The 1985 borings located along this wall are Borings 10, W-9-2, W-9-3, W-9-4, W-9-7, W-30-71, W-31-71 and W-32-71.

As shown in Attachments 2 and 4, the wall height varies from 8 to 27 feet with the finished grade in front of the wall varying from EL49 to EL31. The wall starts at Wall Station 25+10 and ends at Wall Station 180+93.04. The 12-inch by 6-inch levelling pad elevation varies from EL42.04 to EL24.82. The reinforced backfill behind the wall consists of granular fill material and 50 mm by 4 mm steel reinforcing strips. The length of reinforcing strips varies from 10 to 20 feet.

If the wall remains in place, the adequacy of wall bearing resistance and reinforcing strip condition may have to be evaluated for the planned improvements.

Concrete Retaining Walls

The bridge abutments at 12th Street and 18th Street are composed of wrap-around concrete walls that retain the approach fills. The 1985 borings near these bridges have been discussed in Section 4.1.

At 12th Street Bridge

The concrete wingwalls at the north abutment of 12th Street bridge run along Route 1 keeping the roadway elevated over the surrounding ground until its junction with I-395. The west side concrete wingwall at the south abutment abuts Retaining Wall 7 and the east side wall abuts Retaining Wall 9. The foundation information for these concrete walls are not available.

At 18th Street Bridge

The concrete walls at north and south abutments of 18th Street bridge extend to the east where they also supported S. Clark Street bridge superstructure in the past. The east side wingwall of the north abutment abuts Retaining Wall 3, and the west side of the wrap-around wall abuts the Marriott Hotel building. The east side of the south abutment wall abuts 1800 S. Bell Street building, and the west side abuts the Westin Hotel building. The foundation information for these concrete walls is not available.

4.3 Embankment Slopes

The project corridor consists of four embankment slopes at the north and south abutments of the bridge over 15th Street.

West Side Slope at North Abutment of 15th Street Bridge

This embankment slope is supported by Retaining Wall 8. Based on Google Earth imagery, the maximum height of the embankment above the wall appears to be about 5 feet with 4 horizontal to 1 vertical (4H:1V) slope, approximately. The slope is currently well vegetated and appears to be in good condition.

East Side Slope at North Abutment of 15th Street Bridge

This embankment slope is not supported by a retaining wall, and Ramp D is located at the toe of this slope. Based on Google Earth imagery, the maximum height of the embankment above Ramp D street appears to be about 15 feet with 2.75H:1V slope, approximately. The slope is currently well vegetated and appears to be in good condition. If this slope remains unchanged, it may need to be evaluated for the planned improvements using the current design standard applicable for the project area.

West Side Slope at South Abutment of 15th Street Bridge

This embankment slope is supported by Retaining Wall 5. Based on Google Earth imagery, the maximum height of the embankment above the wall appears to be about 7 feet with 5H:1V slope, approximately. The slope is currently well vegetated and appears to be in good condition.

East Side Slope at South Abutment of 15th Street Bridge

This embankment slope is supported by Retaining Wall 6. Based on Google Earth imagery, the maximum height of the embankment above the wall appears to be about 7 feet with 5H:1V slope, approximately. The slope is currently well vegetated and appears to be in good condition.

4.4 Pavements and Minor Structures

The project corridor consists of asphalt concrete pavement along Route 1 NB and SB, associated ramps and side streets. Pavement thickness and roadway subgrade information are not available at this time. Based on Google Earth imagery, HDR identified minor pavement distresses such as longitudinal cracking and transverse cracking on the pavement surface. Although not identified in Google Earth, it is possible

that major distresses such as potholes and pavement rutting are also present within the project corridor. For assessing the adequacy of the existing pavement for the planned improvements, HDR recommends performing a pavement condition assessment and collecting pavement cores and possibly performing a ground penetrating radar (GPR) survey. Overlaying the existing asphalt pavement or removal and replacement may be required for the new traffic conditions, new design life, and the current design standard applicable for the project area.

The project corridor also consists of minor structures such as drainage pipes, street pole lights, traffic signal lights and roadway sign poles. Information on these minor structures should also be collected as they may need to be relocated for the planned improvements.

5.0 Additional Project Considerations

The Route 1 bridge over 18th Street abuts the Marriott Hotel building on the northwest side, the Westin Hotel building on the southwest side and 1800 S. Bell Street building on the southeast side. Retained fill is bearing against the first floor walls at these corners. It should be noted that any planned improvement activities at these corners can affect the building foundations. Care should be taken during excavation adjacent to existing foundations to avoid disturbing existing foundation bearing soils. Temporary shoring (sheet piling or other) may be required to support the excavation and minimize impacts to adjacent structures during construction.

The improvement activities can induce horizontal and vertical (settlement) ground movements. Settlement and vibration impacts on the existing bridge foundations, roadway surfaces, existing buildings, pipes and utilities may need to be evaluated. Minor structures such as drainage pipes, street pole lights, traffic signal lights and roadway sign poles may need to be relocated. We recommend performing a pre- and post-condition survey of the existing structures along Route 1, including settlement monitoring, prior to the start of the construction.

The subsurface soils near the surface in the area of 12th Street and 15th Street consist of organic soils, soils mixed with organic matter and debris such as brick, concrete, glass and wood fragments. These unsuitable materials should be removed for the planned improvements.

Subsurface water was observed from EL31 to EL0 at the time of drilling. These water levels may vary at the time of construction depending on the season and precipitation. The near-surface soils are primarily sandy, and water infiltration rates should be expected to be high during construction. Subsurface water control procedures may need to be developed for the planned improvements.

All major project features including bridge foundations, wall foundations and embankment slopes should be evaluated to verify their adequacy for the planned improvements.

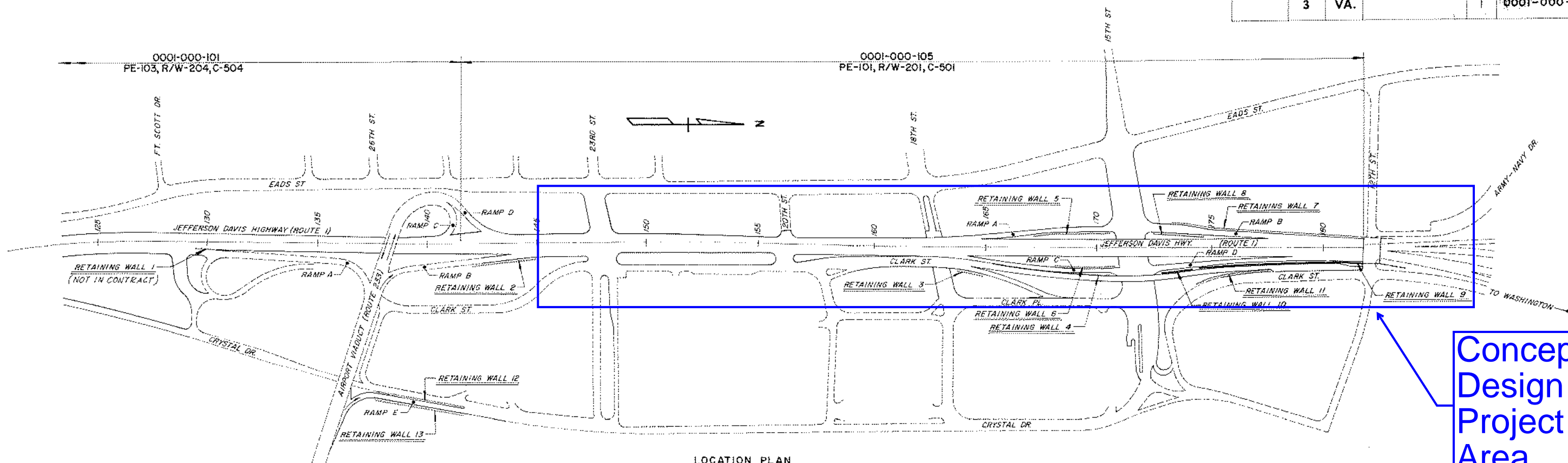
Attachments:

- | | |
|--------------|---|
| Attachment 1 | Concept Design Project Area |
| Attachment 2 | 1985 Boring Location and Wall Location Plan and Elevation |
| Attachment 3 | Project Area Geology and 1985 Boring Logs |
| Attachment 4 | MSE Wall Typical Section and Elevation Drawings by The Reinforced Earth Company and VSL Corporation |

Concept Design Project Area



ATTACHMENT 2
1985 BORING LOCATION AND
WALL LOCATION PLAN AND
ELEVATION



LOCATION PLAN
No Scale

Concept
Design
Project
Area

GENERAL NOTES:

Specifications:
Construction: Virginia Department of Highways and Transportation Road and Bridge Specifications, 1982.

Design: AASHTO Standard Specifications for Highway Bridges, 1977 as modified by current Interim Specifications.

Concrete shall be Class A3.

Deformed reinforcing bars shall conform to ASTM A-615, Grade 60.

⊗ Denotes item to be paid for on basis of plan quantities in accordance with current Road and Bridge Spec's.

** Lump Sum item for cast-in-place walls only.

ESTIMATE OF QUANTITIES

	ITEM	STRUCTURE EXCAVATION	12" PRESTRESSED CONCRETE PILES	DRIVING TEST FOR 12" PRESTRESSED CONC. PILES	CONCRETE CLASS A3	REINFORCING STEEL	CONCRETE SURFACE COLOR COATING TYPE A	STANDARD PG-2A	POROUS BACKFILL	6" PIPE UNDERDRAIN	SUPPORT IN-PLACE PERCO CONDUIT	SELECT BACKFILL
	UNITS	C.Y. ⊗	L.F.	L.F.	C.Y.	LBS.	L.S.**	S.Y.	C.Y.	L.F.	L.F.	C.Y.
WALL 2	FOOTING	655			149.7	11,180						
	NEAT				153.5	16,330	1		15			
WALL 4	FOOTING	2845	1,240	160	719.5	100,500						
	NEAT				790.6	60,640	1		407	521	290	
WALL 5 (STD. RW-3 MOD.)	FOOTING	280*										
	NEAT				250.0*		1*		40*			
WALL 6 (STD. RW-3 MOD.)	FOOTING	220*										
	NEAT				188.0*		1*		30*			
WALL 7	FOOTING	430	520	15	66.7	8,444			34	28		
	NEAT				107.3	8,020	1					
WALL 9	FOOTING	490	690	20	66.7	8,270			31	28		
	NEAT				87.7	6,420	1					
WALL 10	FOOTING	470	5500	190	231.8	17,960						
	NEAT				200.5	18,670	1		142	244		
WALL 11 (STD. RW-3 MOD.)	FOOTING	380	320	40	13.4	1,320						310
	NEAT				424.7		1	130	65			
TOTAL		5,270	14,330	425	3012.1	256,540		130	694	821	290	310

INDEX

	SHEET NO.
Retaining Wall 2	2 thru 5
Retaining Wall 3	6
Retaining Wall 4	7 thru 16
Retaining Wall 5	17
Retaining Wall 6	18
Retaining Wall 7	19 thru 23
Retaining Wall 8	24
Retaining Wall 9	25 thru 29
Retaining Wall 10	30 thru 35
Retaining Wall 11	36 and 37
Retaining Wall 12	38
Retaining Wall 13	38 and 39
Lighting Standard Details	40
Standard Junction Box Details	41
Prestressed Square Concrete Piles	42
Boring Logs	43 thru 52

NOTE:

The Contractor shall submit to the Engineer for approval 45 days in advance of construction details and procedures for support and maintenance of conduit in-place.

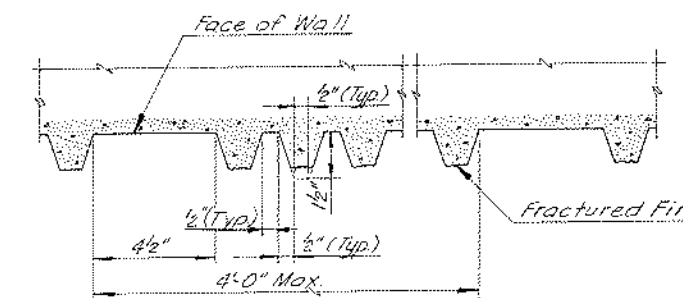
NOTE:

V.D.H.T. Standard RW-3 Modified at walls 5 & 6 is optional alternate to proprietary wall.

* Quantities shown are for information only and are not included in Totals. If this option is selected by contractor, payment will be based on plan quantities for proprietary option bid for other walls.

LEGEND:

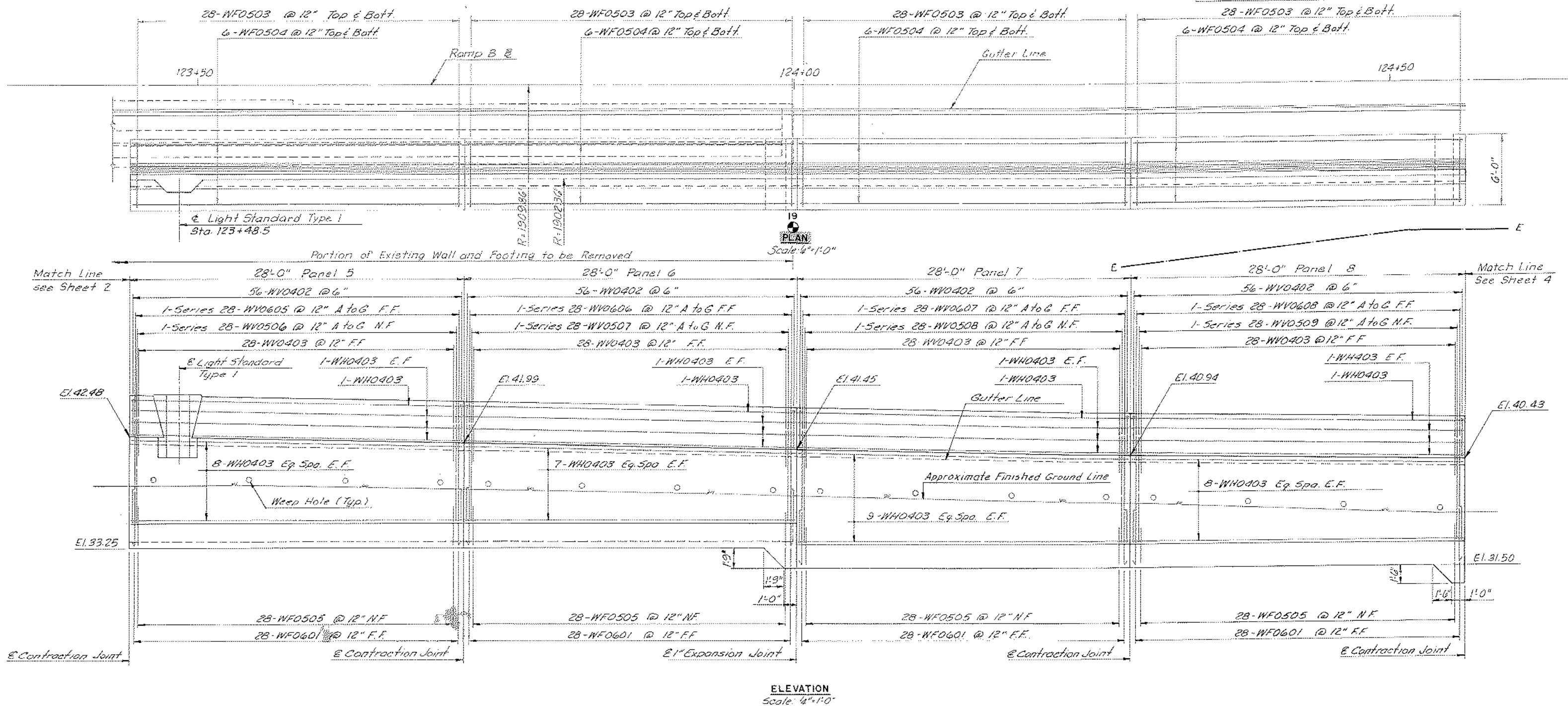
⊗	BORING LOCATION
---	UNDERGROUND TELEPHONE CABLE
---	UNDERGROUND ELECTRIC CABLE



TYPICAL ARCHITECTURAL DETAIL
No Scale

COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION					
RETAINING WALL LOCATION PLAN					
No.	Description	Date	Designed by EUM	Date Sept 5, 1985	Plan No. 65 9 18
Revisions			Checked by TEM	Sheet No. 1 of 52	

ALFVISE	F B I W A AGENCY	STATE	FEDERAL AID PROJECT	STATE PROJECT	DOC#1 NO.
	3	VA.		1 0001-000-105, C-105	22- (3)



NOTE:

The Contractor shall locate and completely expose the existing utility prior to any work in the vicinity of the utility.

The Contractor shall notify Virginia Power of at least 5 days prior to the commencement of work in the vicinity of the utility.

DESIGN BEARING PRESSURE

1.5 Tons per sq ft.

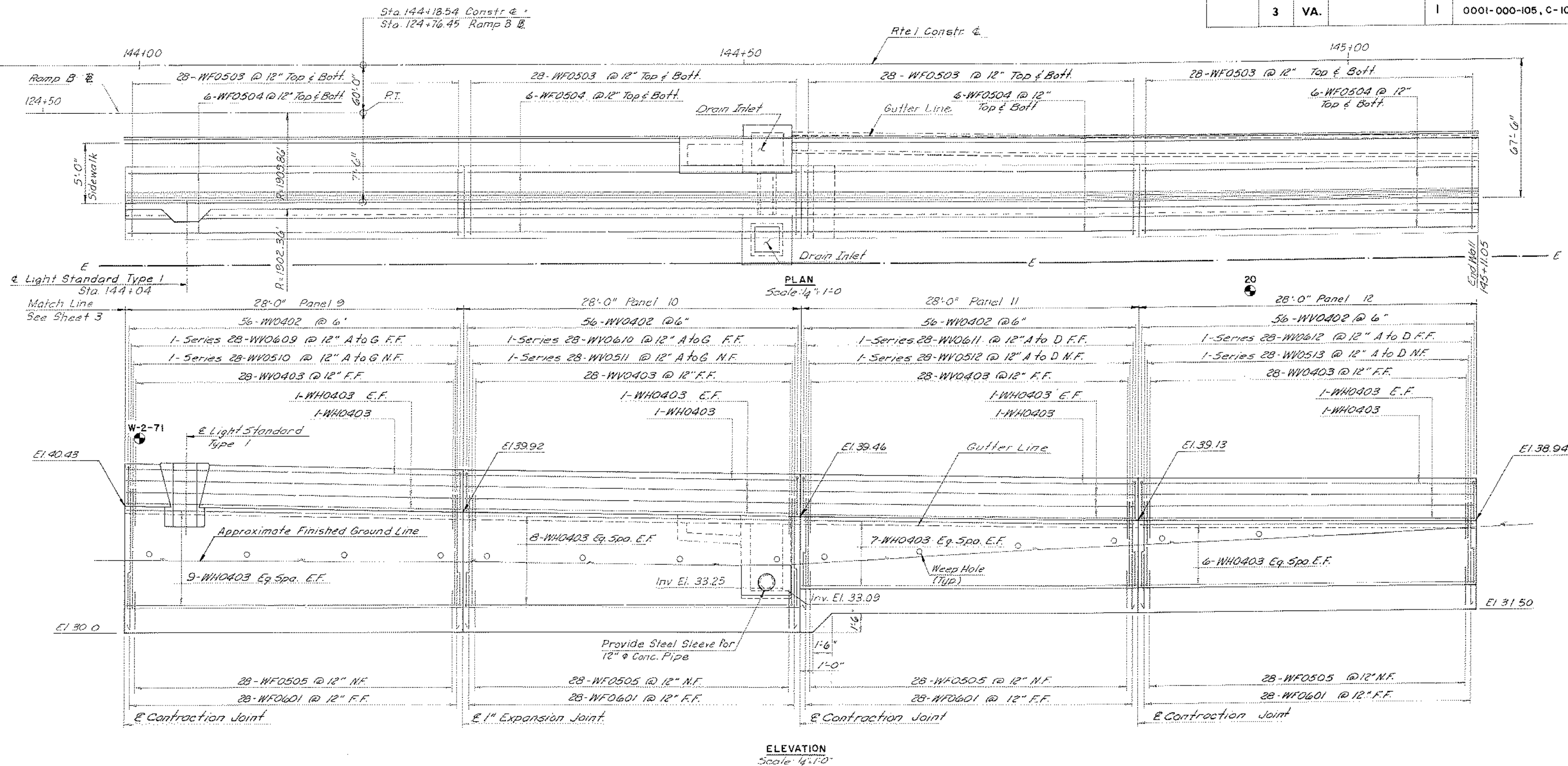
LEGEND:

E.F. = Each Force

N.F. = Near Face

F.F = For Figure

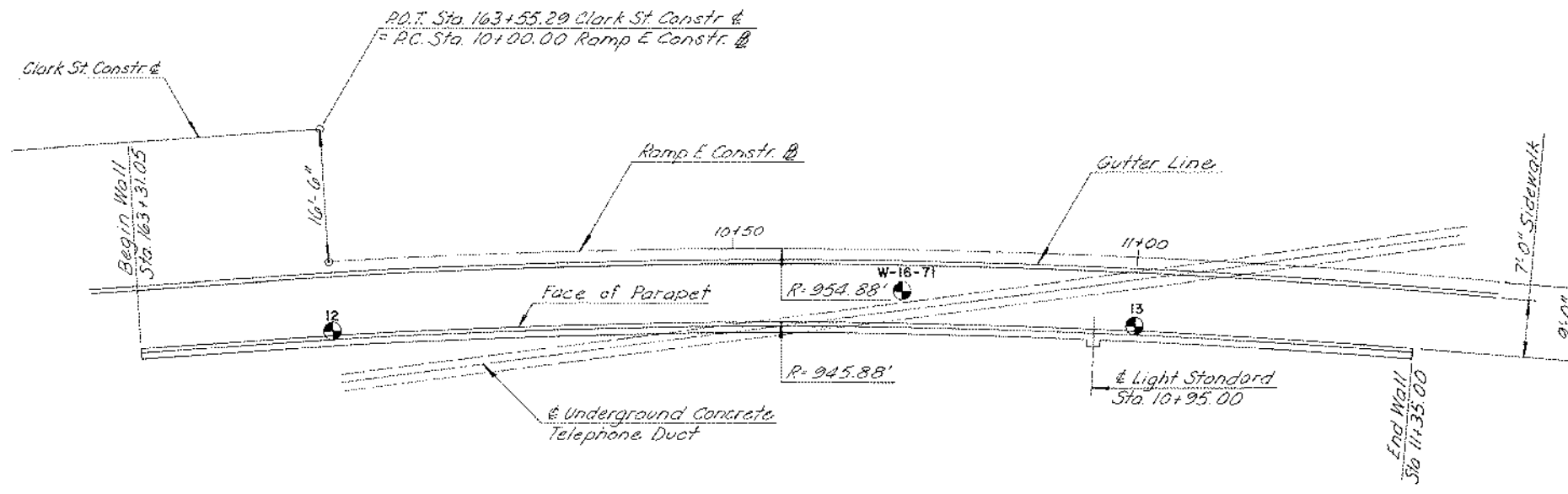
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			RETAINING WALL 2 PLAN & ELEVATION			
			204			
No.	Description	Date	Designed by <u>SR</u> Drawn by <u>TAL</u> Checked by <u>TEM</u>	Date <u>Sept 5, 1985</u>	Plan No. <u>65 9</u>	Sheet No. <u>15 3 of 52</u>
Revisions						



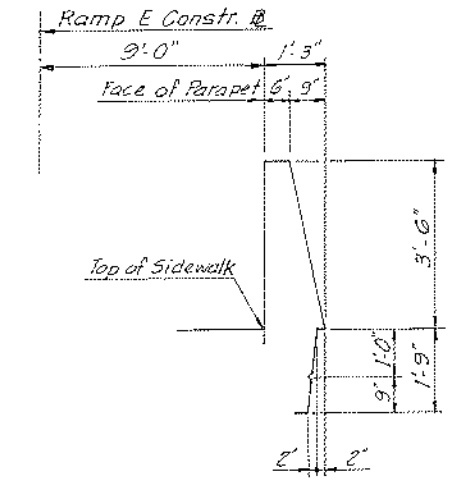
DESIGN BEARING PRESSURE
1.5 Ton per sq. ft.

LEGEND
E.F. = Each Face
N.F. = Near Face
F.F. = Far Face

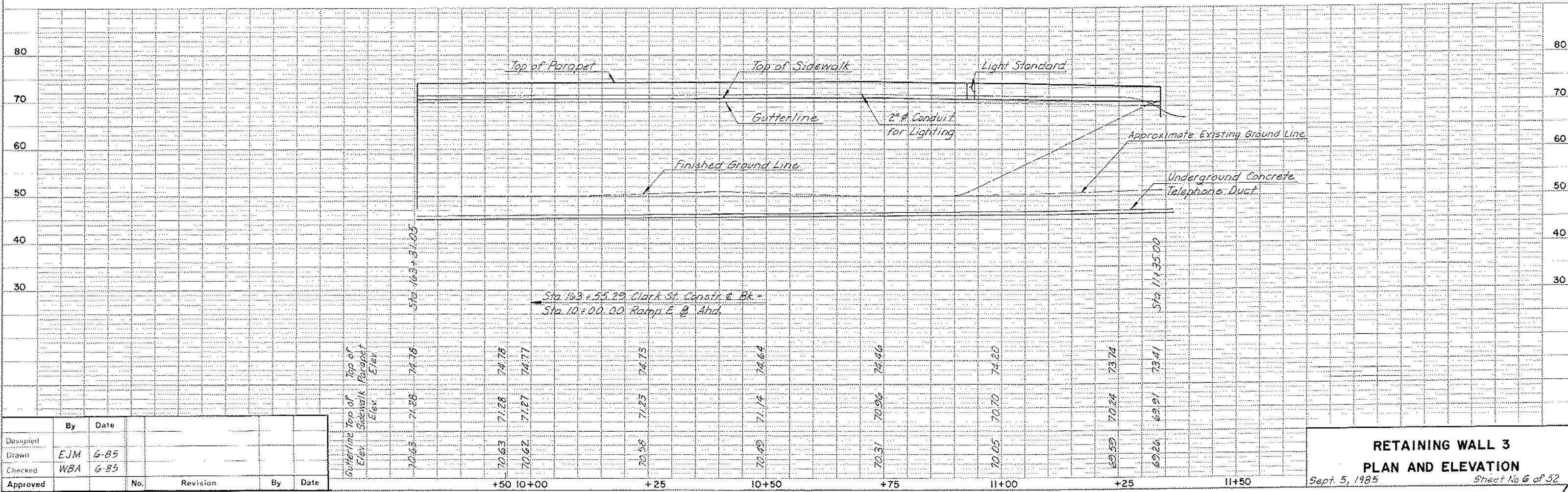
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RETAINING WALL 2 PLAN & ELEVATION					
No.	Description	Date	Designed by <u>SR</u>	Date	Plan No.
			Drawn by <u>JAL</u>	Sept. 5, 1985	65 9 18
			Checked by <u>TEM</u>		Sheet No. 4 of 52



RETAINING WALL 3 PLAN
Scale: 1" = 10'



PARAPET DETAIL

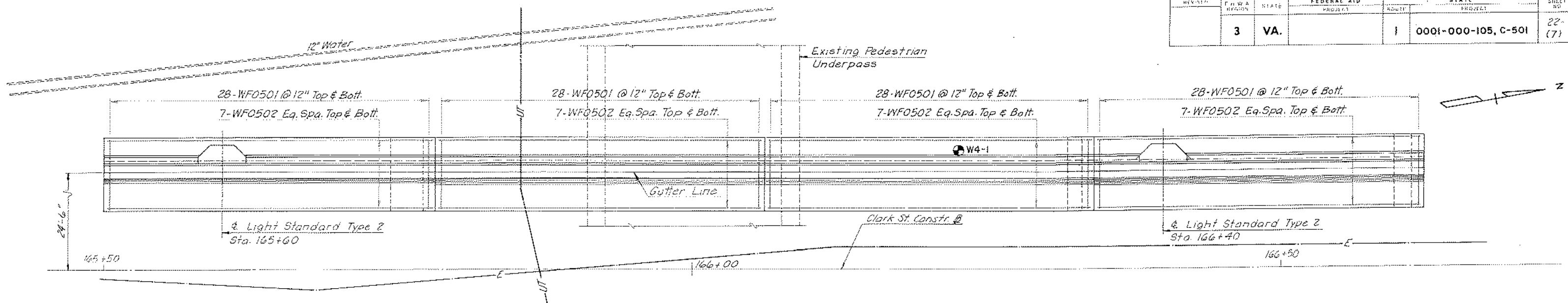


RETAINING WALL 3
PLAN AND ELEVATION

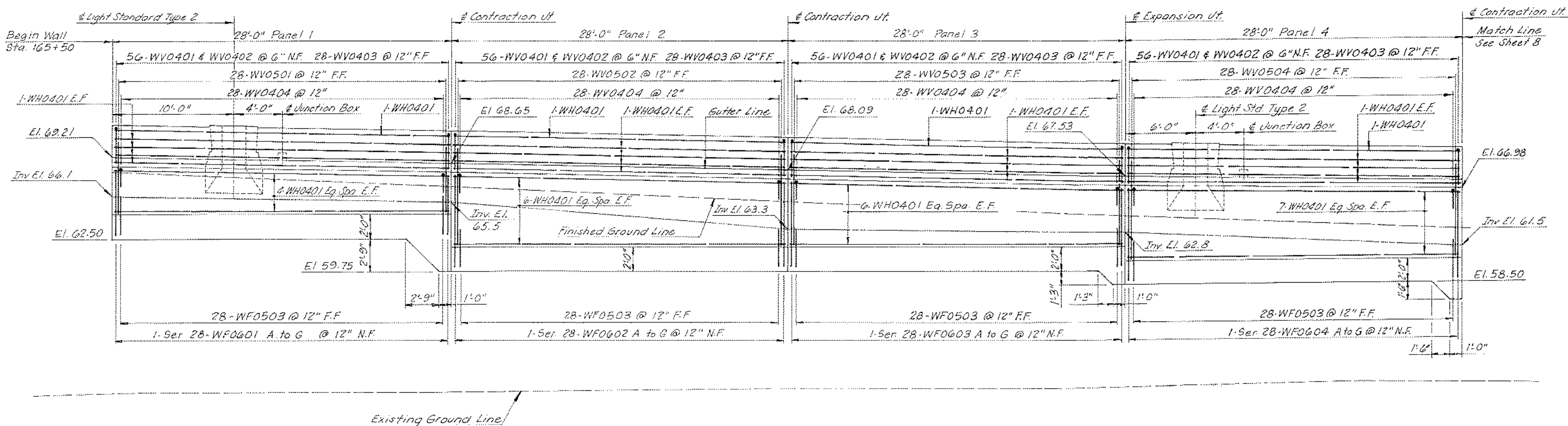
Sept. 5, 1985 Sheet No. 6 of 52

By	Date				
Designed	EJM	6-85			
Drawn	WBA	6-85			
Checked					
Approved			No.	Revision	By Date

REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
3	VA.		1	0001-000-105, C-501	22- (7)



W-17-71
PLAN
Scale 4" = 1'-0"



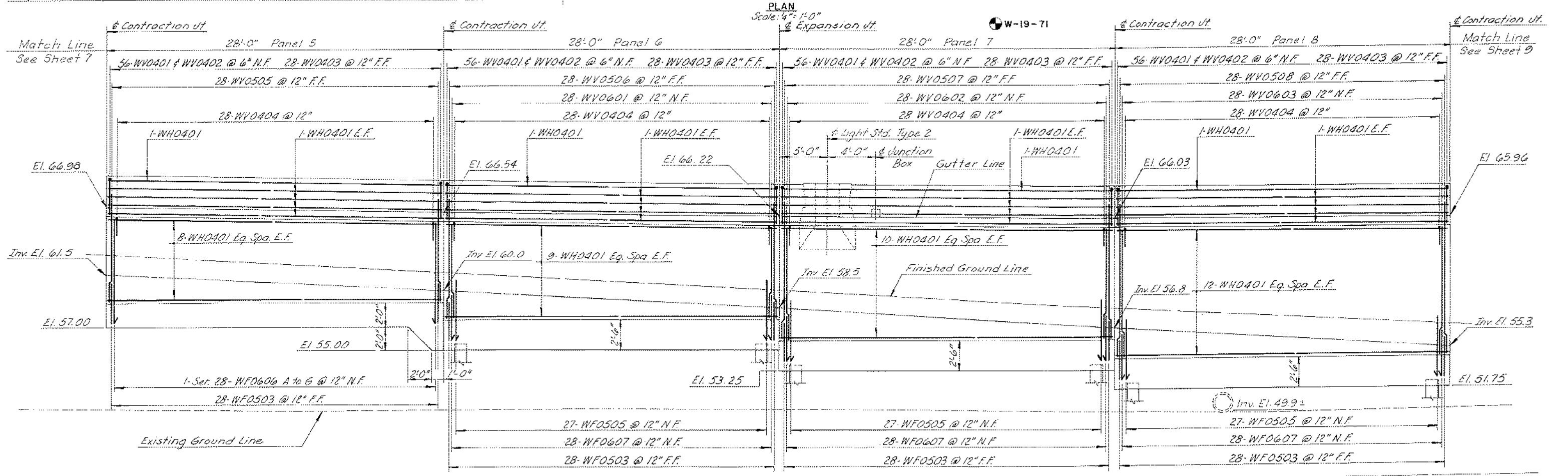
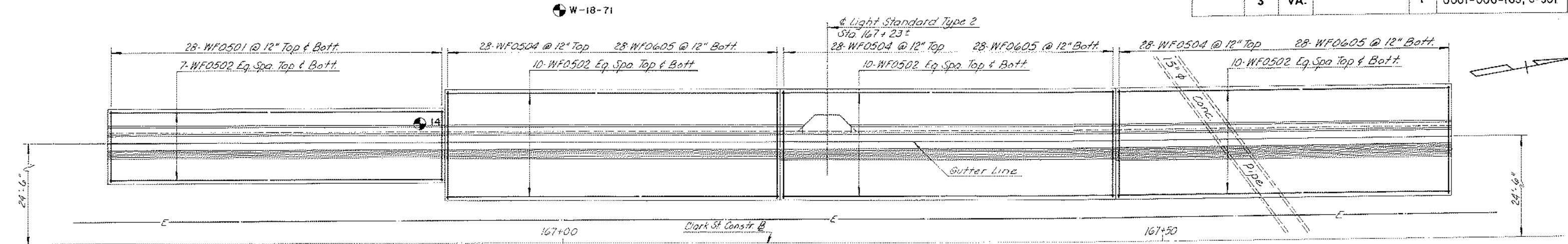
ELEVATION
Scale: 4" = 1'-0"

NOTE:
For Typical Section Panels 1 thru 4,
see Sheet 11.

LEGEND:
E.F. = Each Face
N.F. = Near Face
F.F. = Far Face

DESIGN BEARING PRESSURE:
Panels 1 thru 5 - 1.5 tons/sq. ft.

COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION					
RETAINING WALL 4 PLAN & ELEVATION					
No.	Description	Date	Designed by	Date	Plan No.
			SR		
			Drawn by	Sept. 5, 1985	
			Checked by		
			WBA		
Revisions			Sheet No.		
			7 of 52		



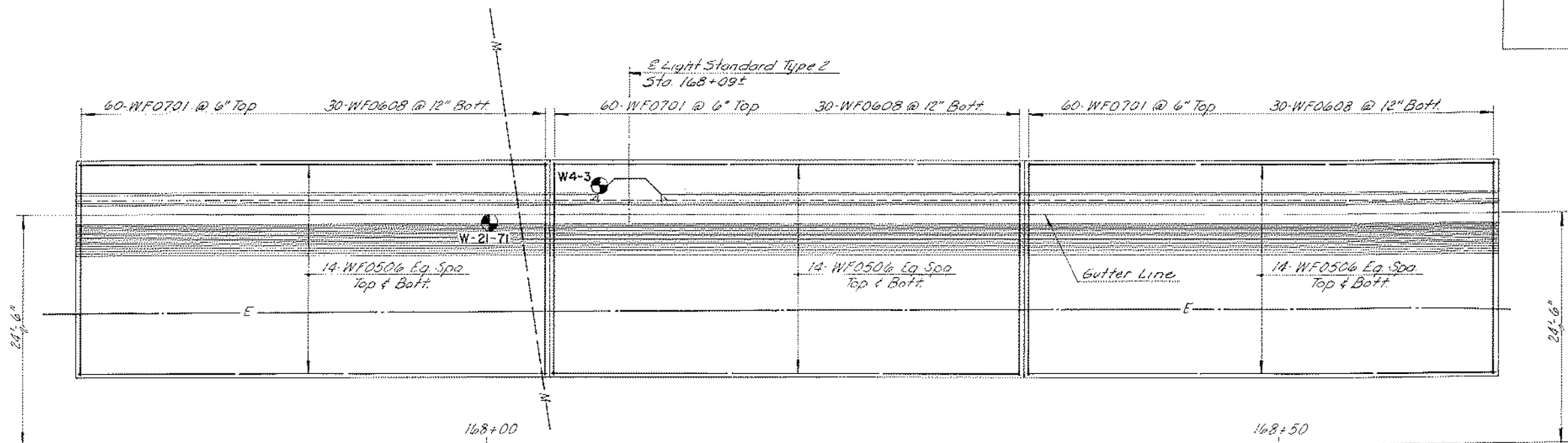
ELEVATION
Scale: 1/4" = 1'-0"

NOTE:
For Pile Plans Panels 6 & 7, see Sheet 11.
For Pile Plan Panel 8, see Sheet 12.
For Typical Section Panels 5 thru 8, see Sheet 17.

LEGEND:
E.F. = Each Face
N.F. = Near Face
F.F. = Far Face

Approximate Top of
Exist. Electrical Duct

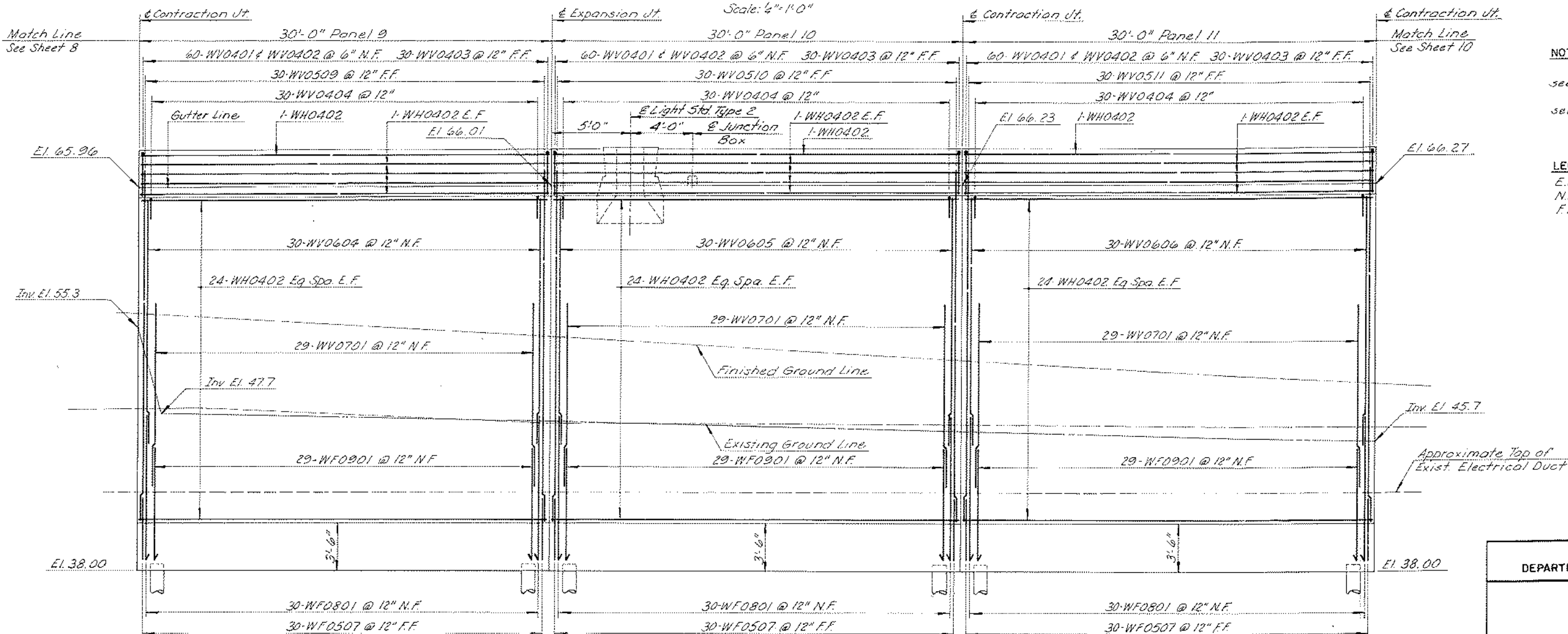
COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION					
RETAINING WALL 4 PLAN & ELEVATION					
No.	Description	Date	Designed by <i>SR</i>	Date	Plan No. <i>65 9 18</i>
Revisions			Drawn by <i>EJM</i>	Sept. 5, 1985.	Sheet No. <i>8 of 52</i>
			Checked by <i>WBA</i>		



PLAN
Scale: 1/4" = 1'-0"

NOTE:
For Pile Plan Panels 9 thru 11,
see Sheet 11.
For Typical Section Panels 9 thru 11,
see Sheet 11.

LEGEND:
E.F. = Each Face
N.F. = Near Face
F.F. = Far Face



ELEVATION
Scale: 1/4" = 1'-0"

No.	Description	Date

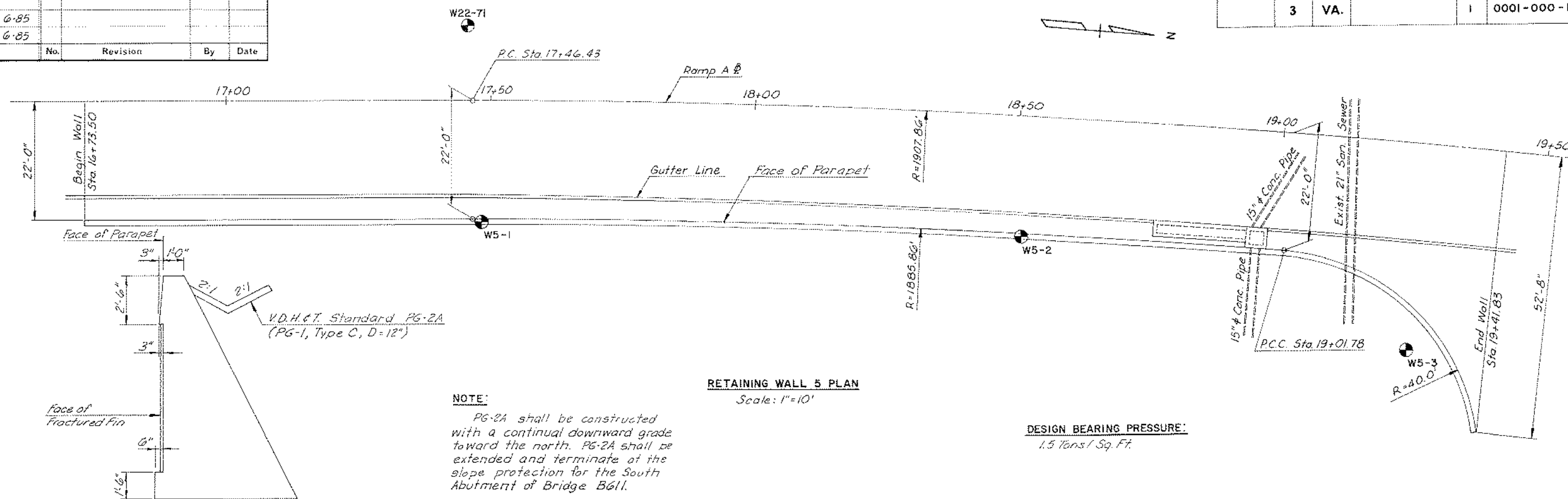
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION

RETAINING WALL 4 PLAN & ELEVATION

Designed by	Date	Plan No.	Sheet No.
SR	Sept. 5, 1985	66 9 18	9 of 52
Drawn by			
Checked by			

By	Date				
Designed	JGV	6-85			
Drawn	WBA	6-85			
Checked					
Approved			No.	Revision	By Date

REVISION	DATE	STATE	FEDERAL AID	ROUTE	STATE PROJECT	SHEET NO.
3	VA.			1	0001-000-105,0-501	22-17

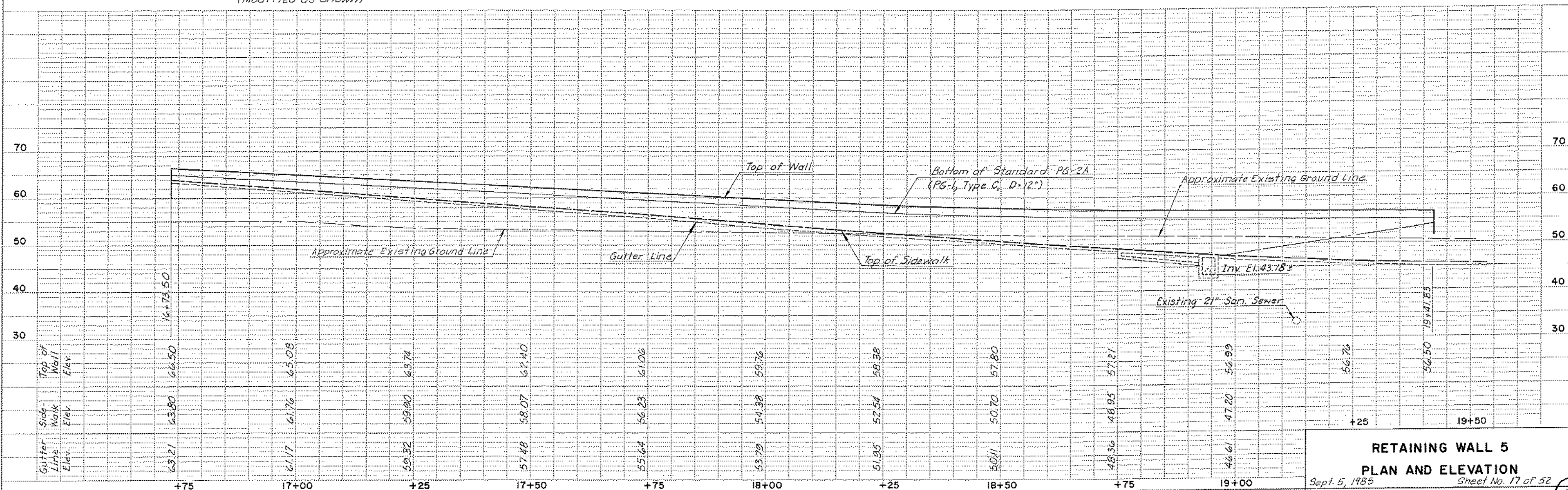


RETAINING WALL 5 PLAN
Scale: 1"=10'

DESIGN BEARING PRESSURE:
1.5 Tons/Sq. Ft.

NOTE:
PG-2A shall be constructed with a continual downward grade toward the north. PG-2A shall be extended and terminate at the slope protection for the South Abutment of Bridge B611.

V.D.H. & T. STANDARD RW-3
(Modified as Shown)



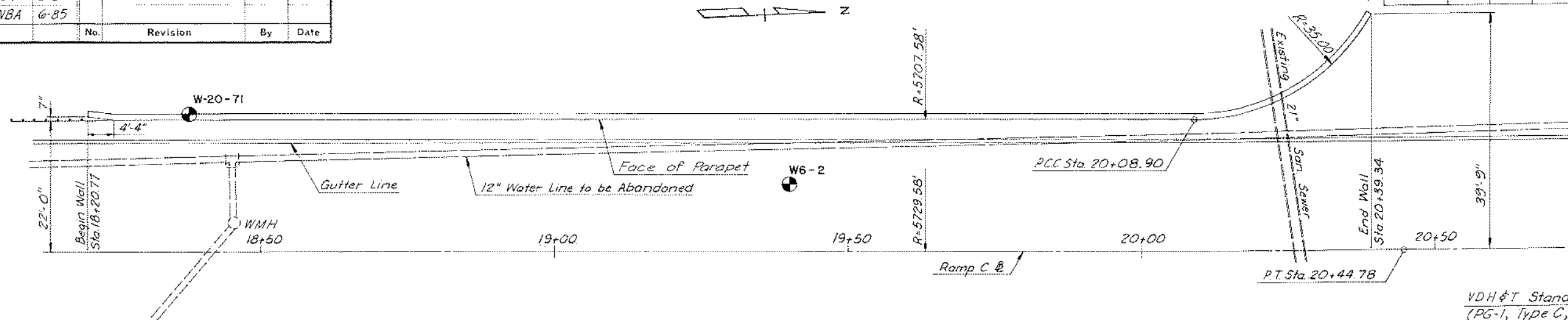
RETAINING WALL 5
PLAN AND ELEVATION

Sept. 5, 1985

Sheet No. 17 of 52

By	Date	No.	Revision	By	Date
Designed					
Drawn	JGV 6-85				
Checked	WBA 6-85				
Approved					

REVISED	F.J. W.A. #	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		1	0001-000-105,C-501	22-118

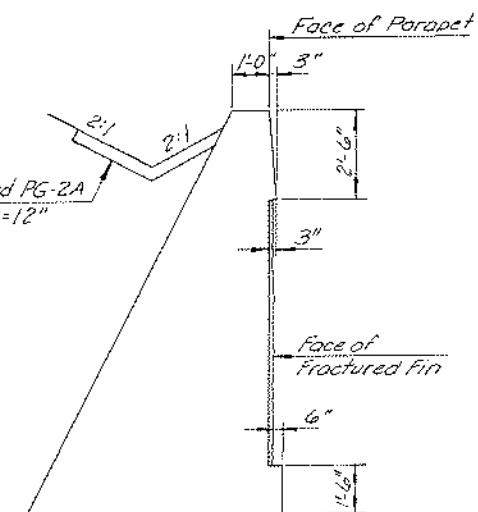


RETAINING WALL 6 PLAN
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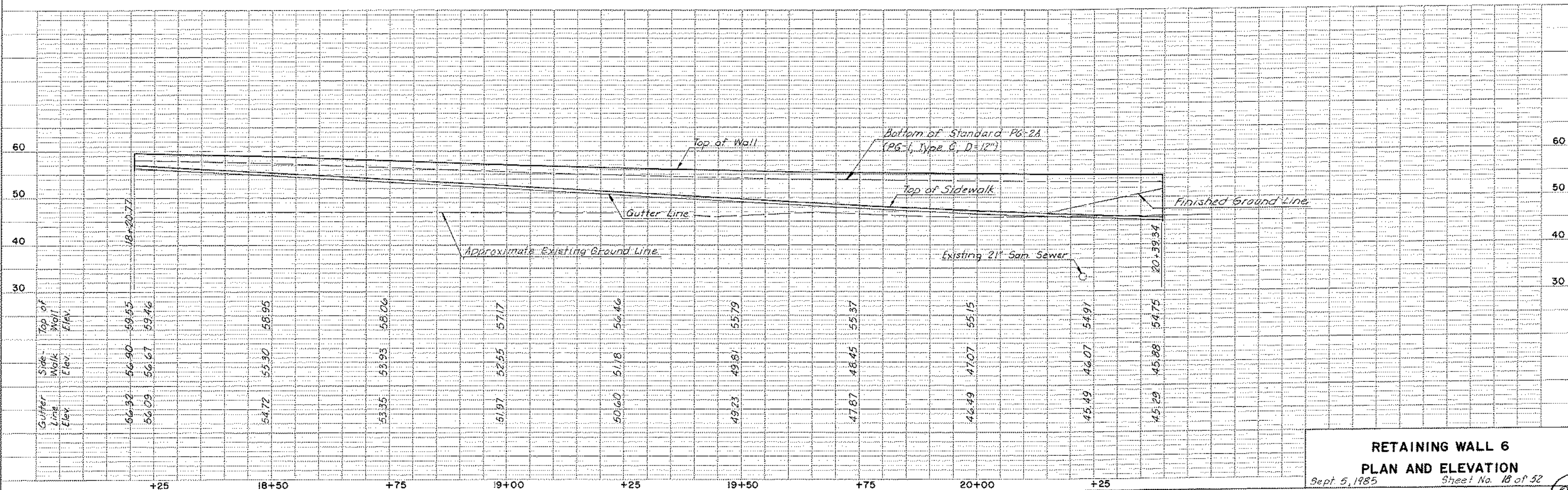
DESIGN BEARING PRESSURE:
1.5 Tons/Sq. Ft.

NOTE:

PG-2A shall be constructed with a continual downward grade toward the north. PG-2A shall be extended and terminate at the slope protection for the South Abutment of Bridge B611.



VDH & T. STANDARD RW-3
(Modified as Shown)



RETAINING WALL 6

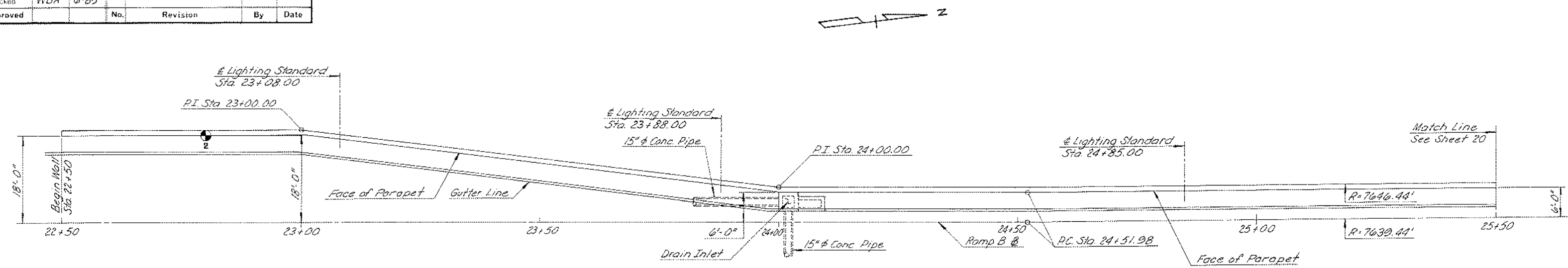
PLAN AND ELEVATION

Sept. 5, 1985

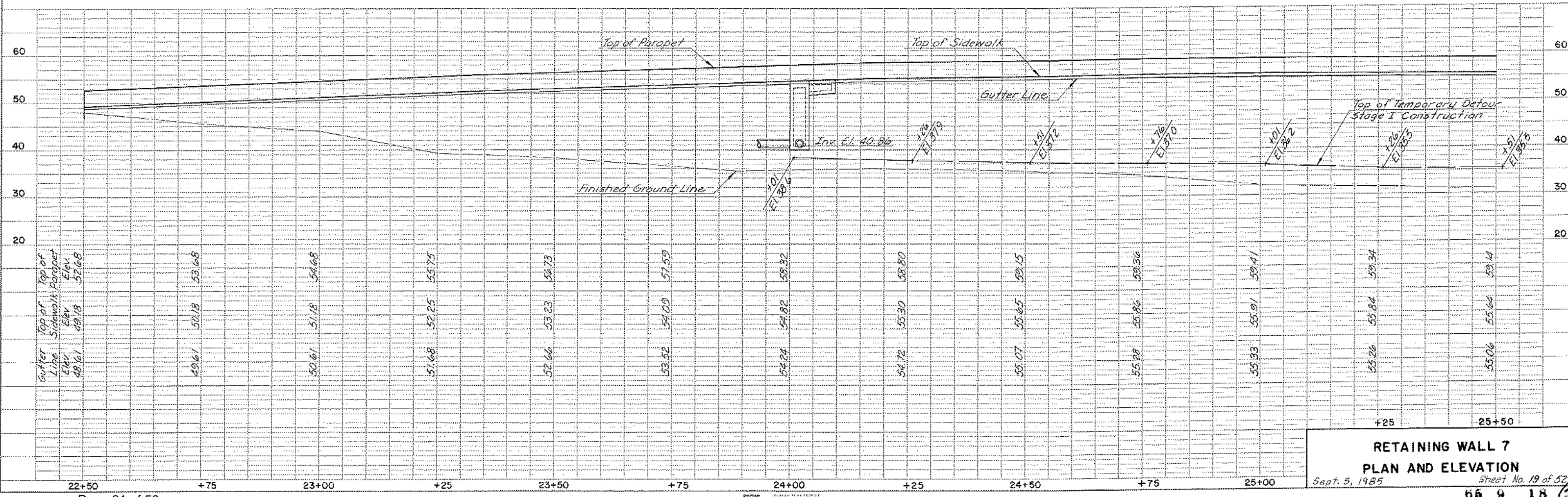
Sheet No. 18 of 52

Designed	By	Date			
Drawn	JGV	6-85			
Checked	WBA	6-85			
Approved			No.	Revision	By Date

REVISED	F.I.C.W.A. REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		1	0001-000-105, C-501	28-19



RETAINING WALL 7 PLAN
STA 22+50 TO 25+50
Scale: 1" = 10'

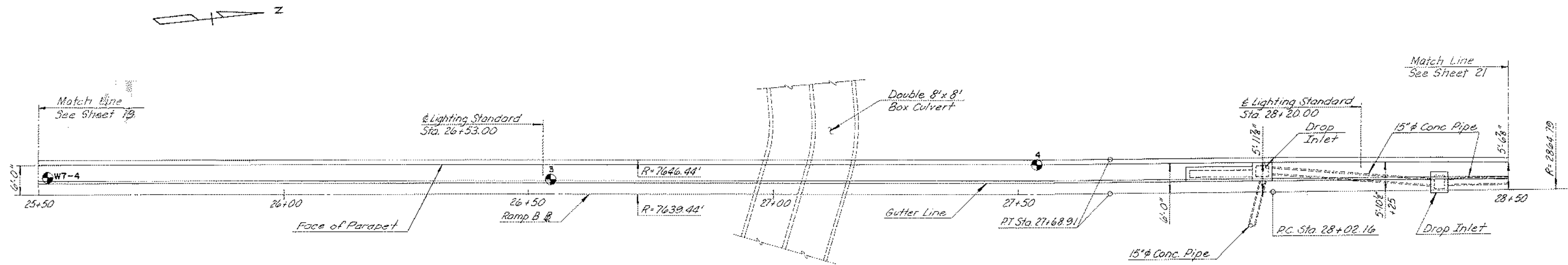


RETAINING WALL 7
PLAN AND ELEVATION

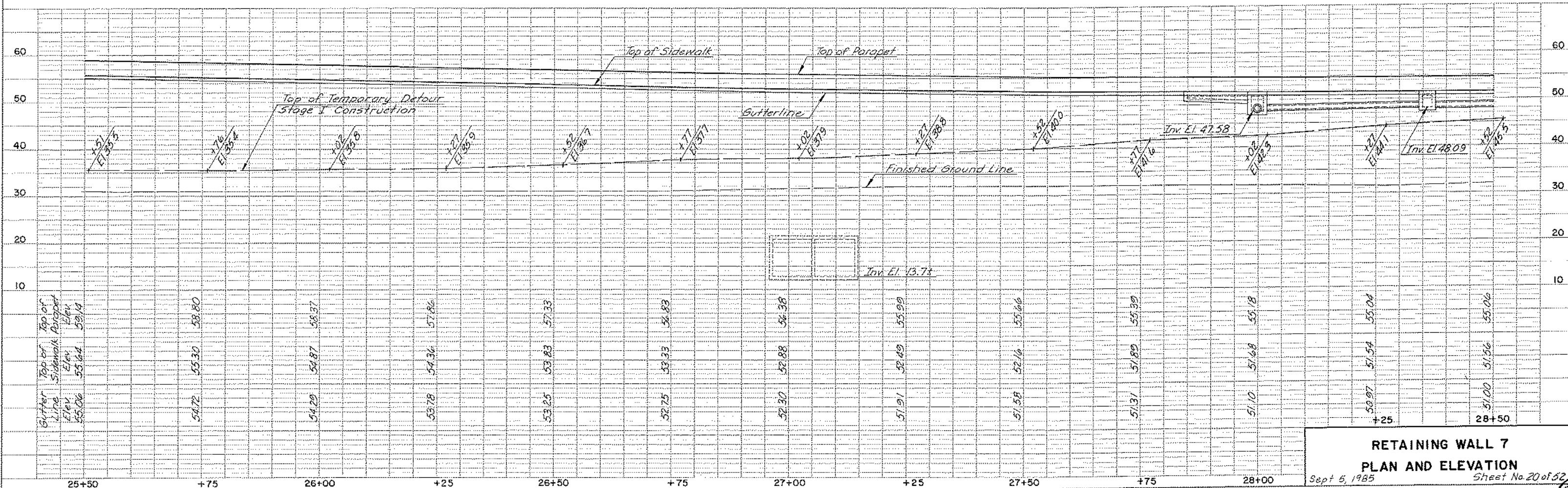
Sept. 5, 1985 Sheet No. 19 of 52

Designed	By	Date			
Drawn	JGV	6-85			
Checked	WBA	6-85			
Approved			No.	Revision	By Date

REVISION	F.H.W.A. REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		1	0001-000-105, C-501	22- (20)



RETAINING WALL 7 PLAN
STA. 25+50 TO 28+50
Scale: 1" = 10'



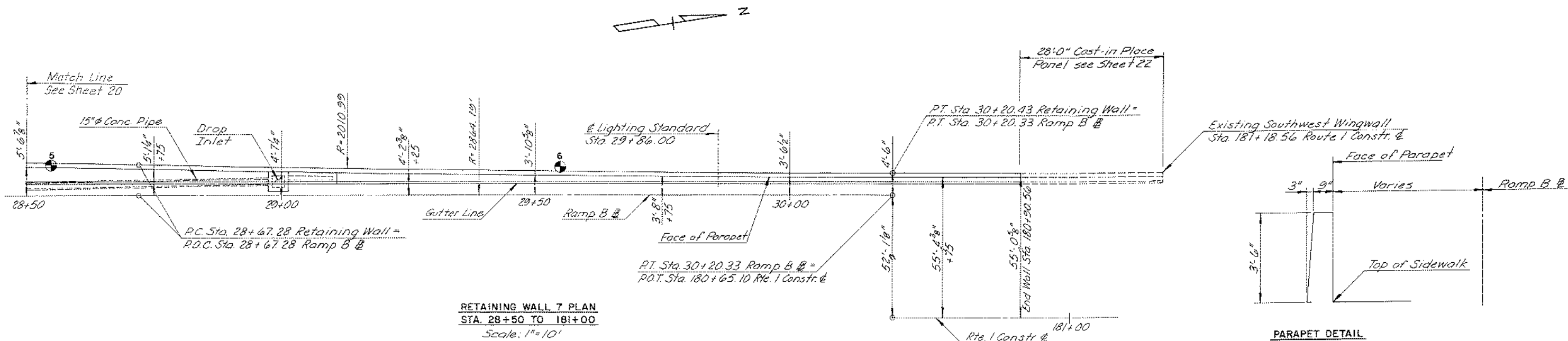
RETAINING WALL 7
PLAN AND ELEVATION

Sept 5, 1985

Sheet No. 20 of 52

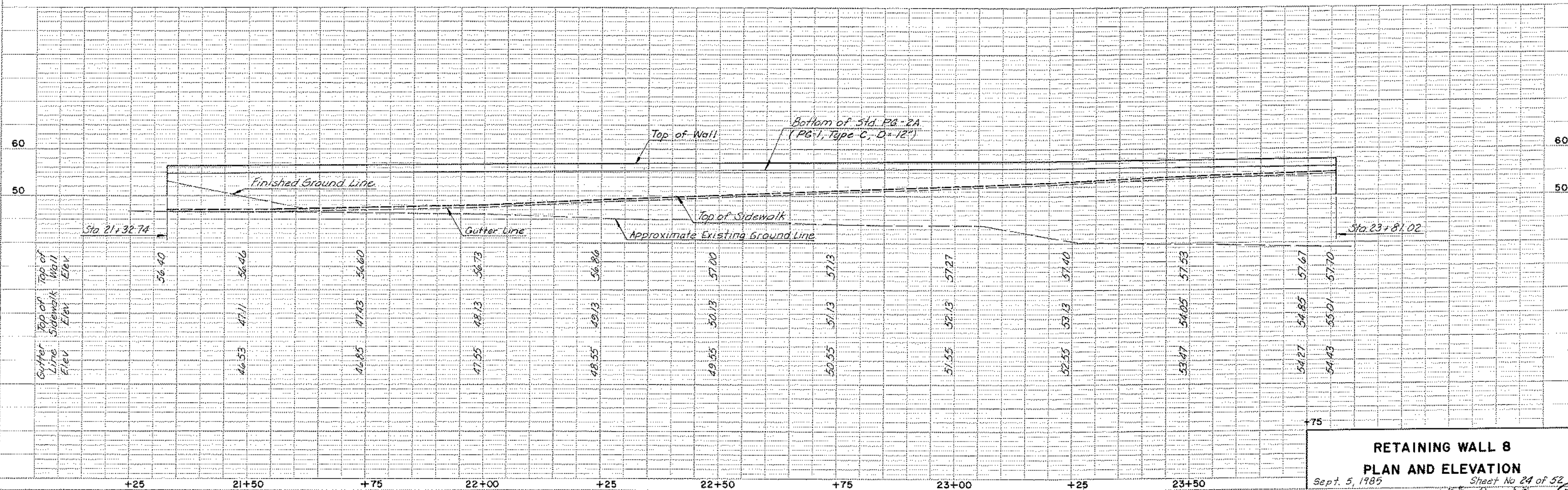
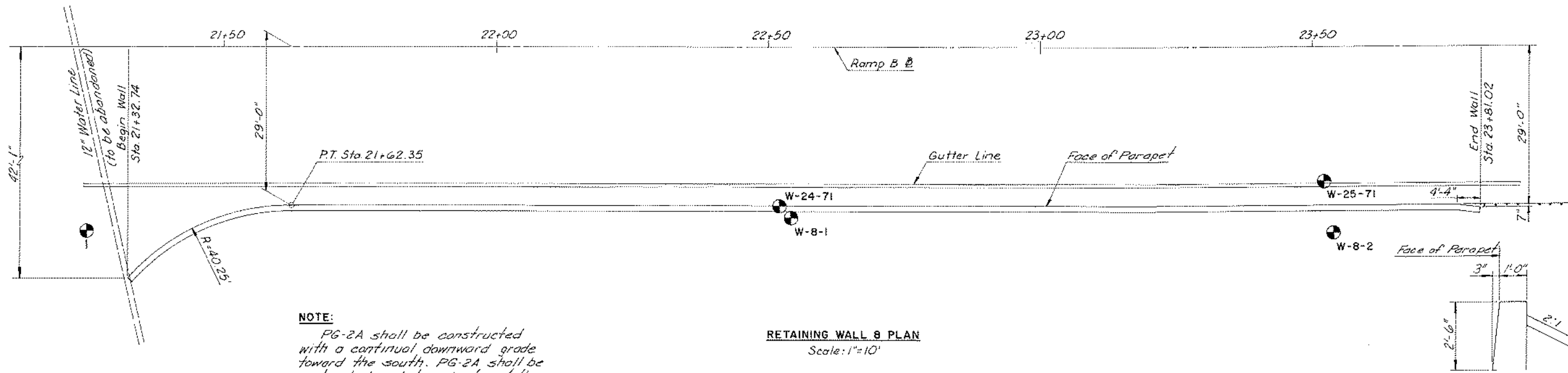
By	Date	No.	Revision	By	Date
Designed					
Drawn	EJM 6-85				
Checked	TEM 6-85				
Approved					

REVISION	FLW A. 425-00	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
3	VA.	1	0001-000-105, C-501			22- (21)



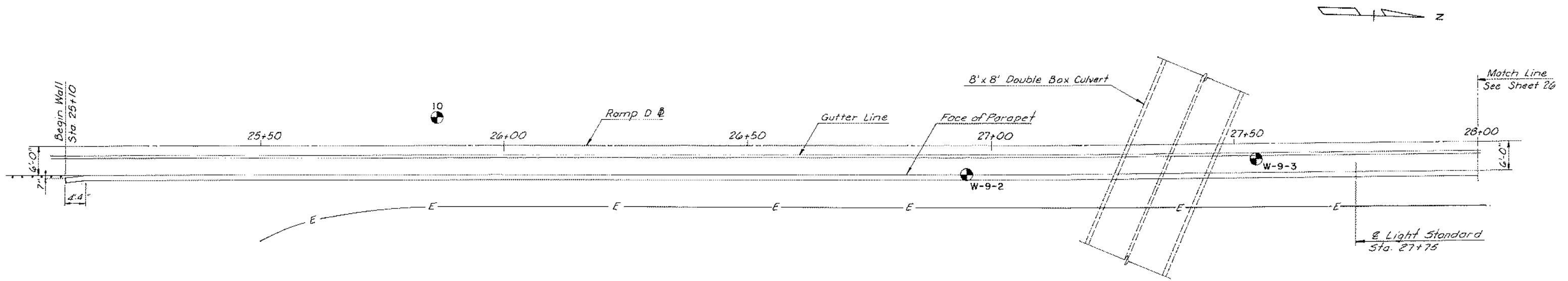
Designed	By	Date			
Drawn	EJM	6-85			
Checked	WBA	6-85			
Approved			No.	Revision	By Date

PROJECT NO.	STATE	FEDERAL AID	SECTION	SHEET	DATE
3	VA.			1	0001-000-105, C-501
					22- (24)

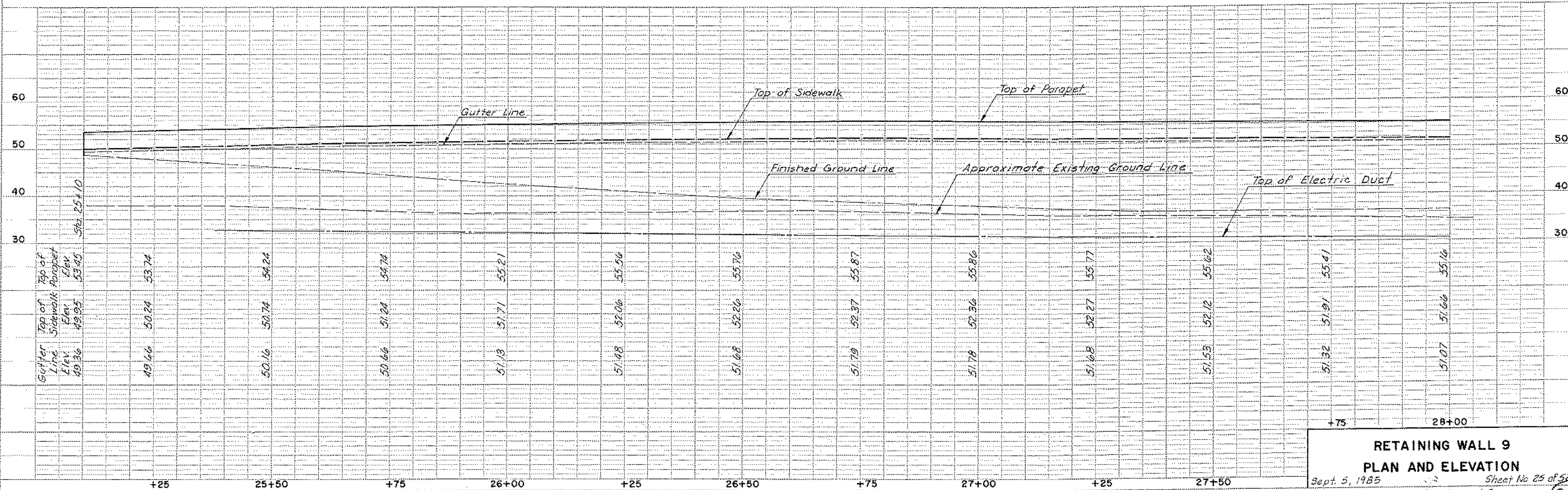


Designed	By	Date			
Drawn	JGV	6-85			
Checked	WBA	6-85			
Approved			No.	Revision	By Date

PROJECT	DATE	FEDERAL AID	PROJECT	SHEET	NO.
3	VA.			1	0001-000-105, 22- C-501 (25)



RETAINING WALL 9 PLAN
Scale: 1"=10'

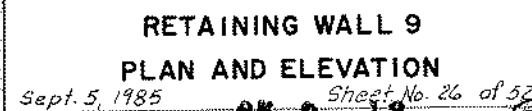
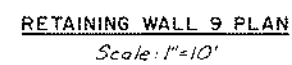


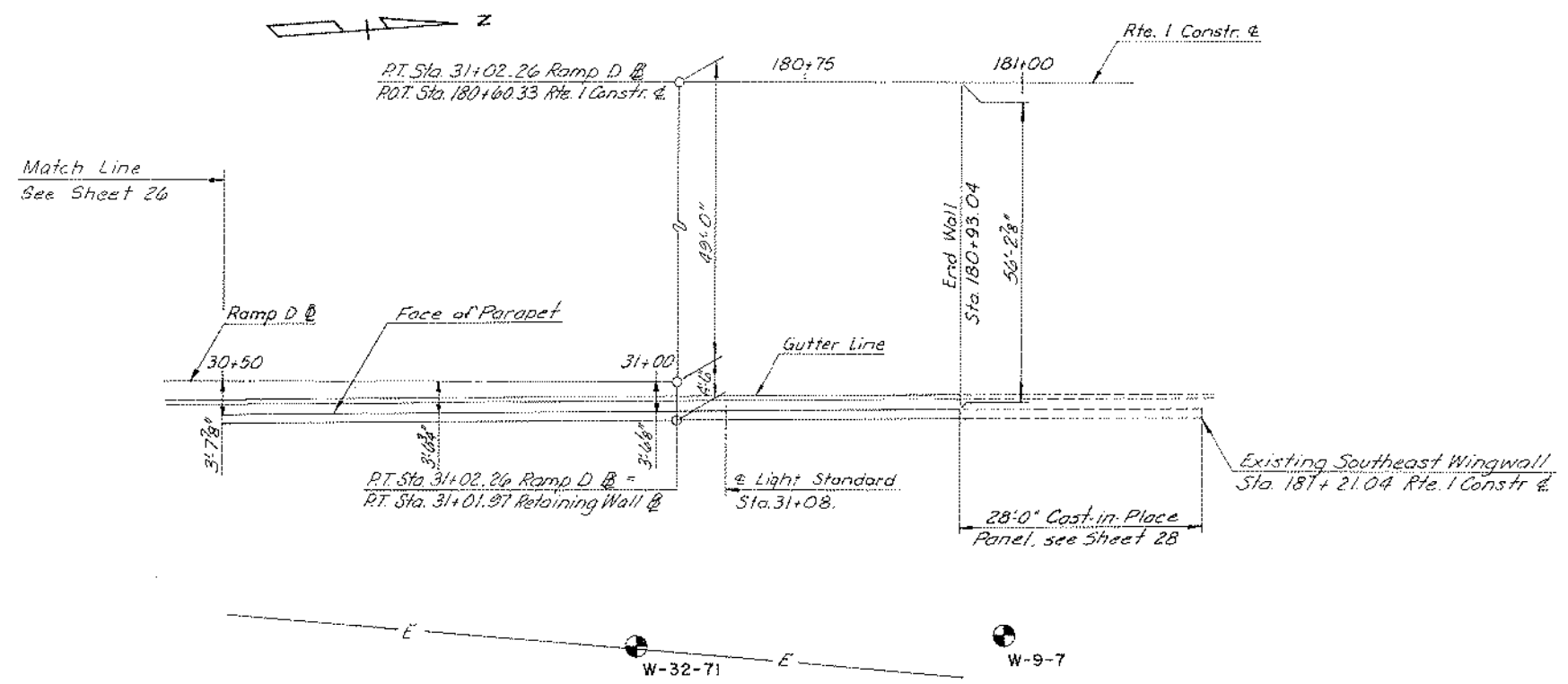
RETAINING WALL 9
PLAN AND ELEVATION

Sept. 5, 1985

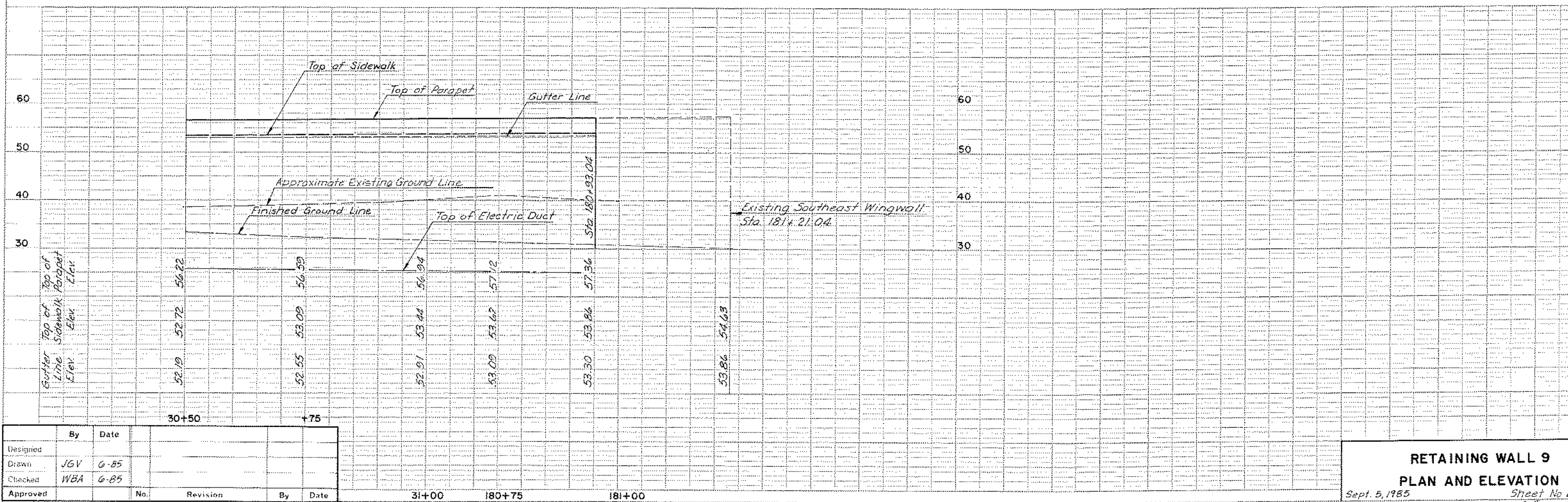
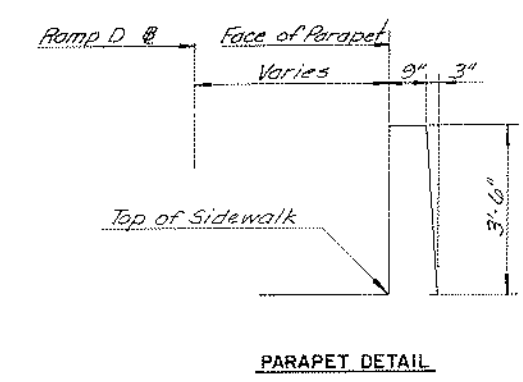
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NEW YORK STATION	STATE	FEDERAL AID PROJECT NO.	DATE	0001-000-106, C-501	22- (26)
3	VA.		1		



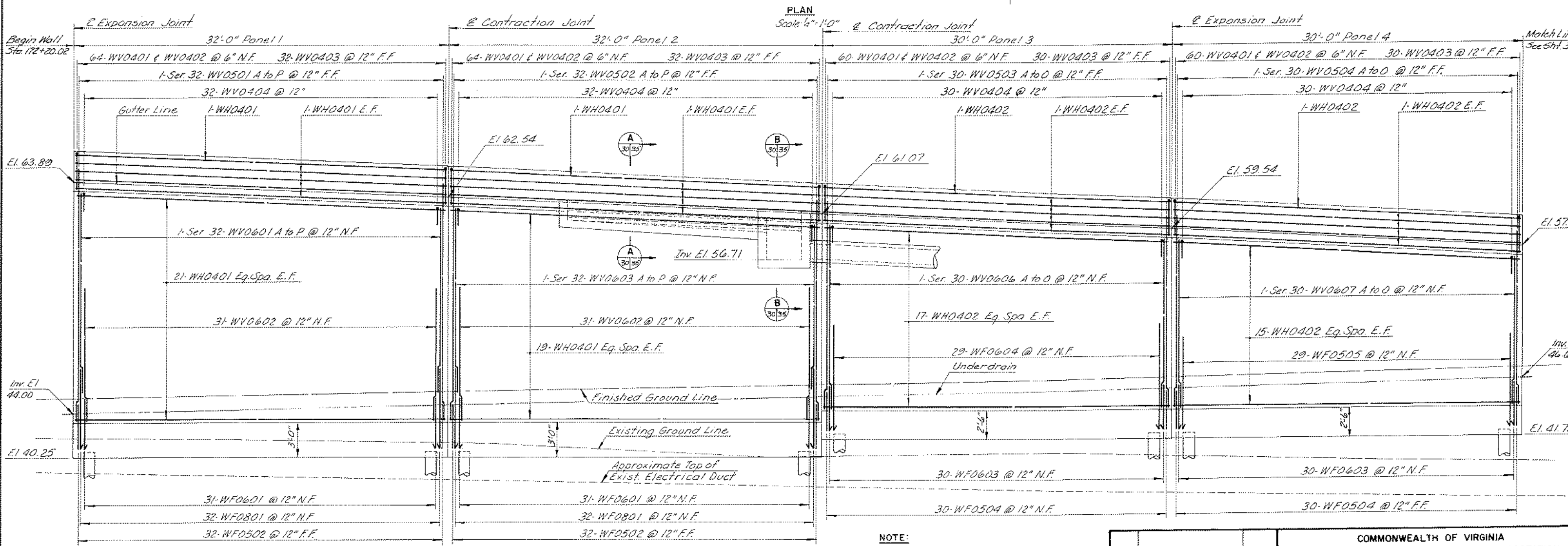
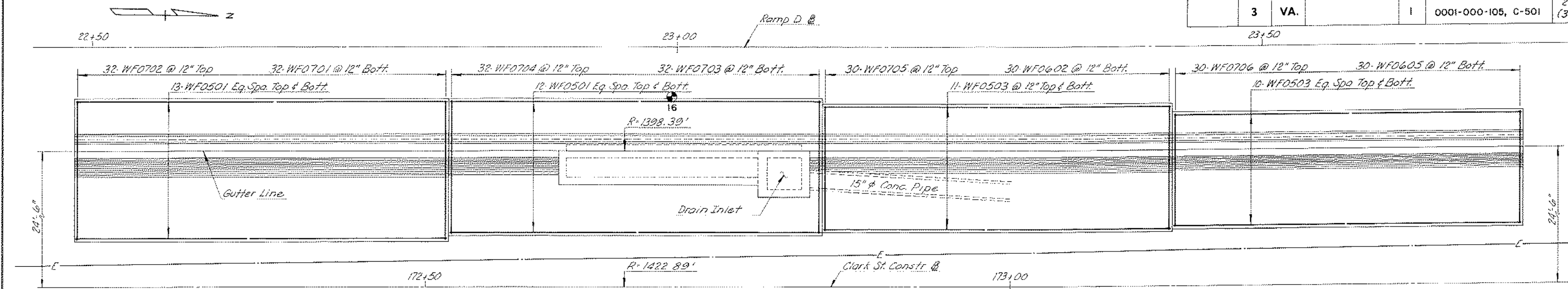


RETAINING WALL 9 PLAN
Scale: 1"=10'



By	Date	No.	Revision	By	Date
Designed					
Drawn	JGV 6-85				
Checked	WBA 6-85				
Approved					

RETAINING WALL 9
PLAN AND ELEVATION



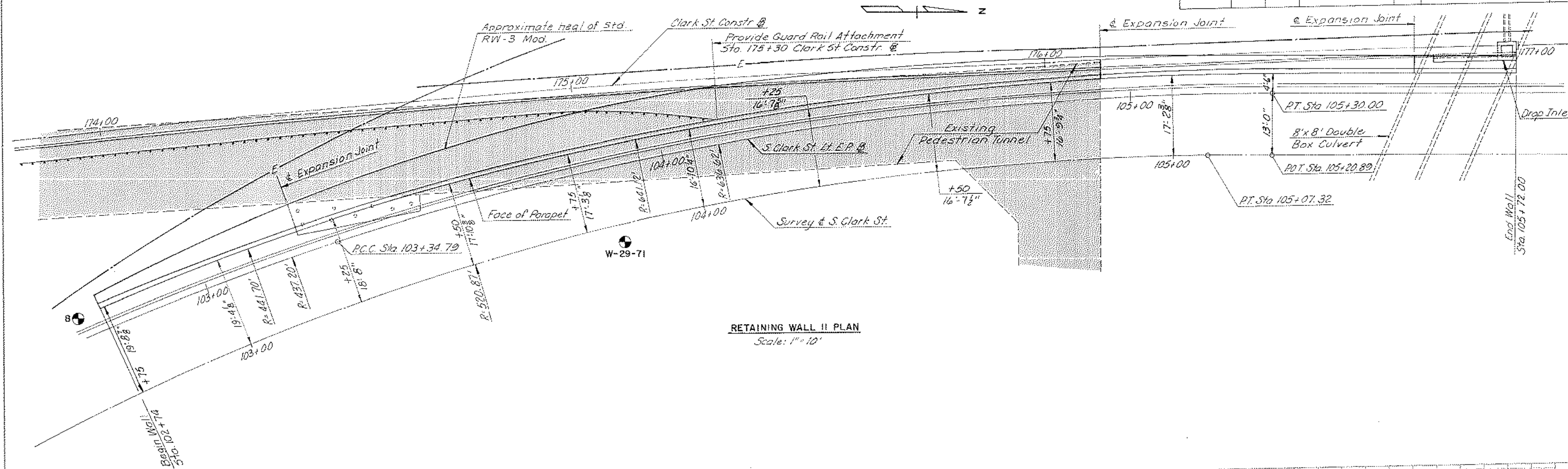
LEGEND:
 E.F. = Each Face
 F.F. = Far Face
 N.F. = Near Face

NOTE:
 For Pile Plans Panels 1 thru 4, see Sheet 33.
 For Typical Section Panels 1 thru 4, see Sheet 32.

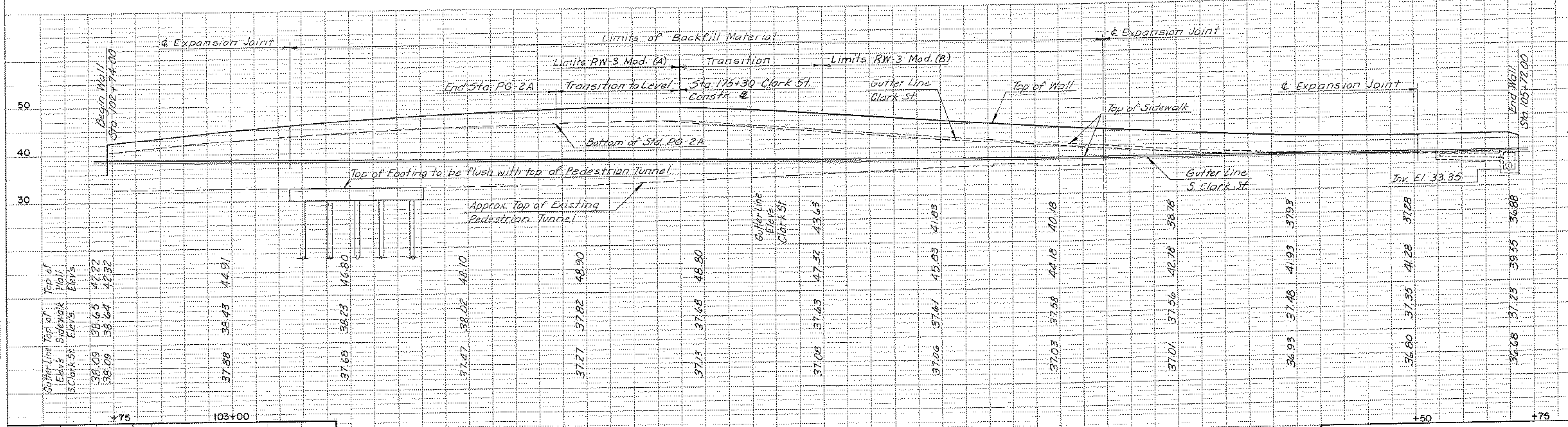
ELEVATION
 Scale: 1/4" = 1'-0"

NOTE:
 Panel Lengths are measured along Gutter Line Clark St.
NOTE:
 Vertical Bars in Near Face of wall are to be bent and cut as necessary to clear inlet. Provide additional bars as shown in Section A and B.

COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION					
RETAINING WALL 10 PLAN & ELEVATION					
No.	Description	Date	Designed by SR	Date	Plan No.
			Drawn by EJM	Sept. 5, 1985	Sheet No. 30 of 32
Revisions			Checked by WBA		



RETAINING WALL II PLAN
Scale: 1" = 10'



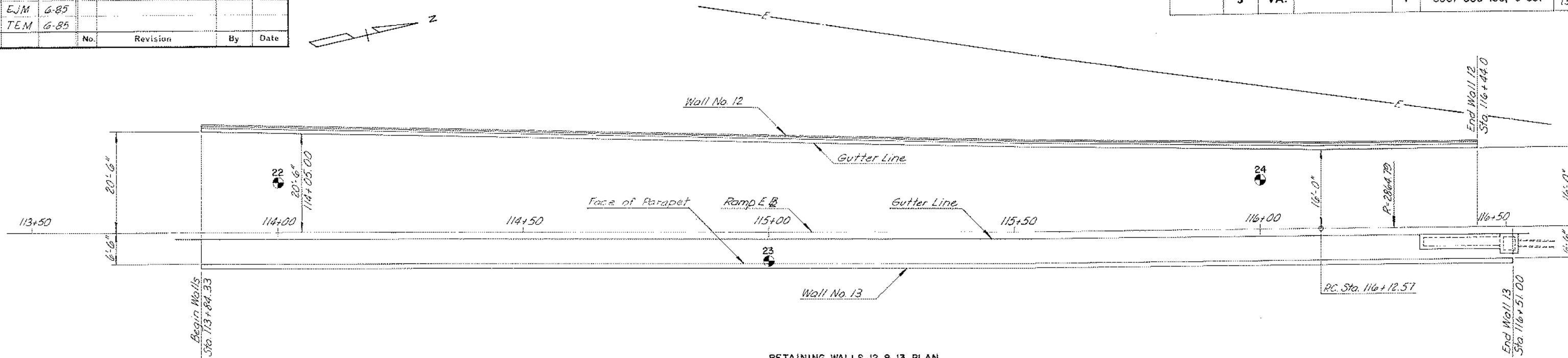
Designed	By	Date
Drawn	TEM	6-85
Checked	WBA	6-85
Approved		

RETAINING WALL II
PLAN AND ELEVATION

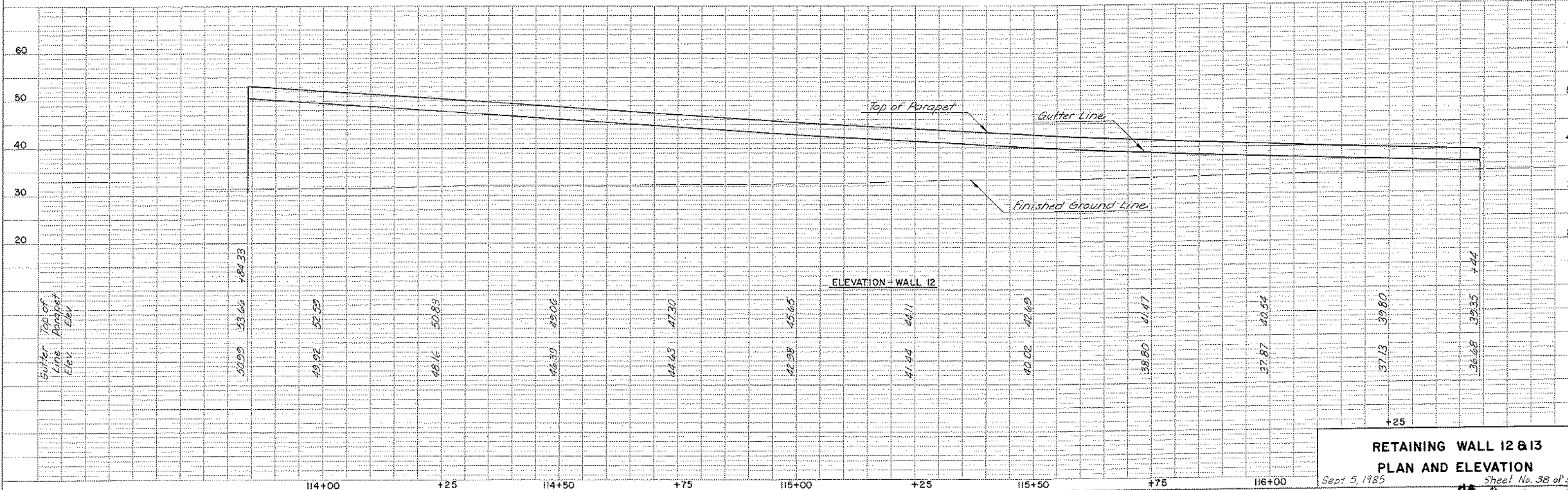
Sept. 5, 1985 Sheet No. 36 of 52

Designed	By	Date			
Drawn	EJM	6-85			
Checked	TEM	6-85			
Approved			No.	Revision	By Date

REVISED	P.H.W.A. REVISION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT
	3	VA.		1	0001-000-105, C-501



RETAINING WALLS 12 & 13 PLAN
Scale: 1" = 10'

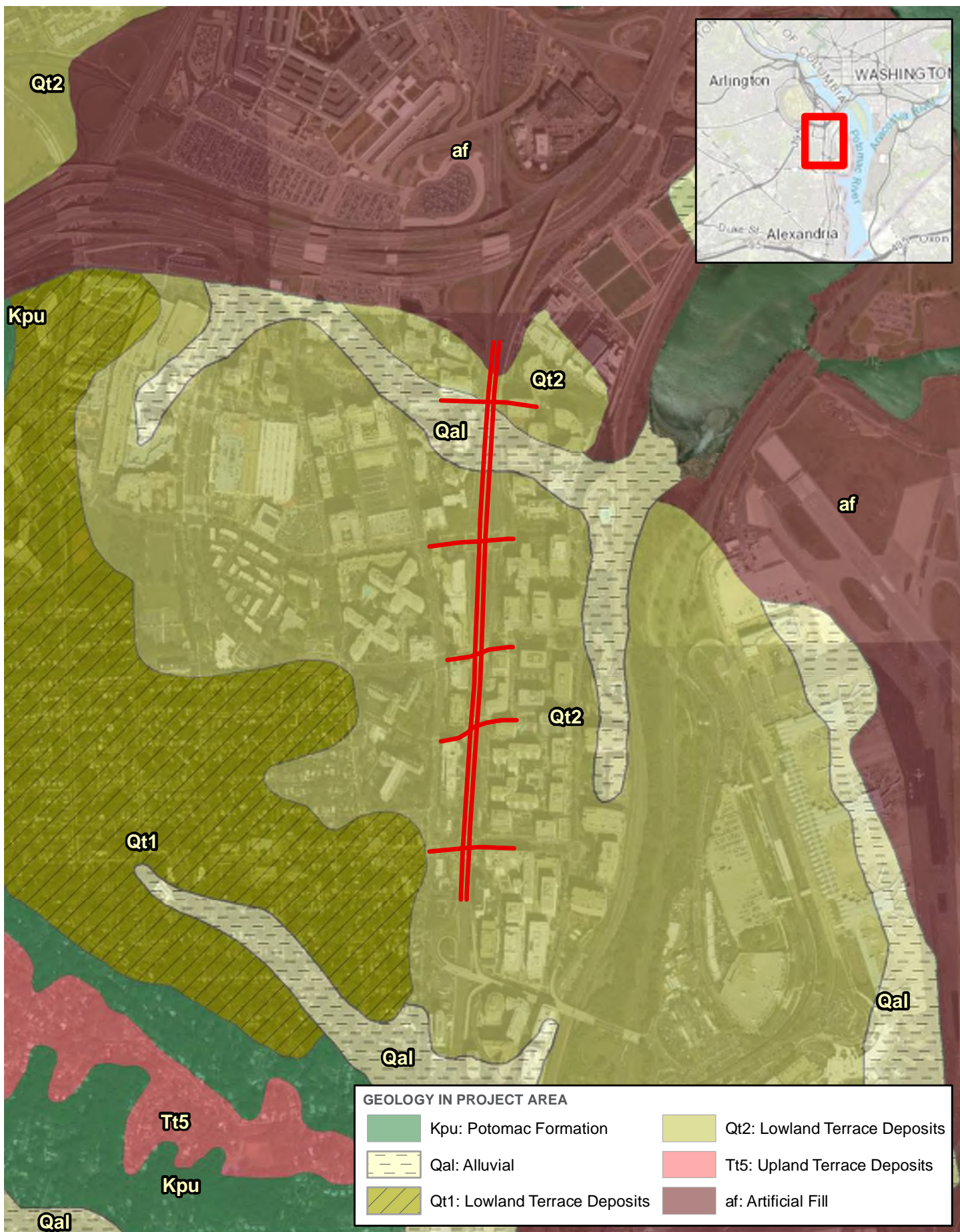


RETAINING WALL 12 & 13
PLAN AND ELEVATION

Sept 5, 1985

Sheet No. 38 of 5

ATTACHMENT 3
PROJECT AREA GEOLOGY
AND 1985 BORING LOGS



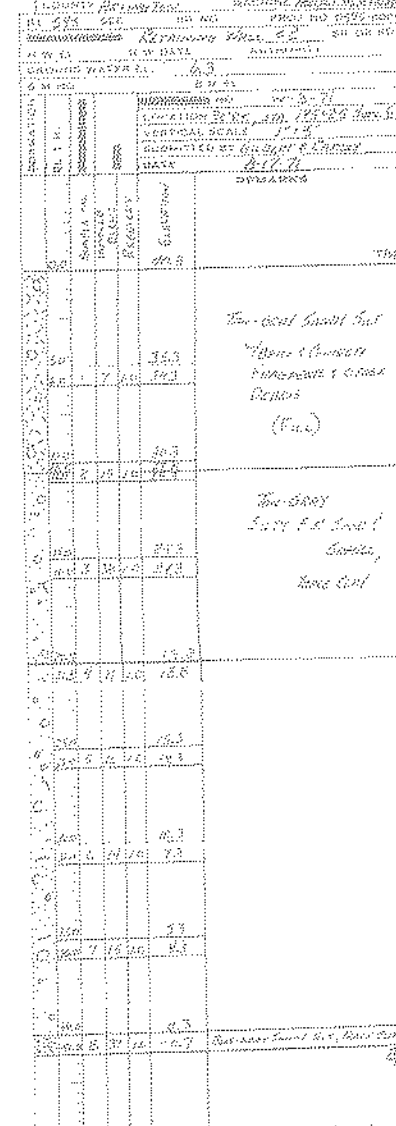
— Project Corridor



**VDOT ROUTE 1 MULTIMODAL IMPROVEMENTS
AREA GEOLOGY**

DATA SOURCE: ESRI, Arlington County

PATH: \ICLTS\MAIN\GIS\PROJECTS\83978_KIMLEYHORN_NORTHERNVA\10254979_RTE1_MULTIMODALIMPROVEMENTS\7.2_WORKING\MAP_DOCS\MXD\RT1_GEOLOGY.MXD - USER: AMCMAHON - DATE: 11/10/2020



Subsurface information shown on this drawing was obtained solely for use in establishing design conditions for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

Page 34 of 59

Boring 14A

Notes: (change to Return Savings
to Bureau of Nat'l Sec Affairs)

Administrative Management in
Education T & International Affairs
Division

1. Quercus L. Agrifolia Robinson 10
 2. Quercus L. agrifolia Robinson 10
 3. Quercus L. agrifolia Robinson 10
 4. Quercus L. agrifolia Robinson 10
 5. Quercus L. agrifolia Robinson 10
 6. Quercus L. agrifolia Robinson 10
 7. Quercus L. agrifolia Robinson 10
 8. Quercus L. agrifolia Robinson 10
 9. Quercus L. agrifolia Robinson 10
 10. Quercus L. agrifolia Robinson 10

Wm. H. Sargent

Blue-Grey Squirrel
Trace Only

None - No Licenses from State #1

Not. Walter Reed K. Kopp
June 1900
R. S. Datta.

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

No.	Description	Date	Designed by	Date	Plan No.	Sheet No.
			Drawn by <i>WBF</i>	<i>Sept. 5, 1985</i>	<i>65</i>	<i>44 of 52</i>
	Revisions		Checked by <i>WBA</i>			

BORING 14

[illegible]

BORING W-18

[illegible]

BORING W-19

[illegible]

BORING W-21

1. Location Barro Colorado Barro Colorado Barro Colorado
 2. Altitude 1000 1000 1000 1000
 3. Latitude 9° 15' N 9° 15' N 9° 15' N 9° 15' N
 4. Longitude 84° 15' W 84° 15' W 84° 15' W 84° 15' W
 5. Date 10/10/77 10/10/77 10/10/77 10/10/77
 6. Time 08:00 08:00 08:00 08:00
 7. Observer J. L. L. J. L. L. J. L. L. J. L. L.
 8. Weather Cloudy Cloudy Cloudy Cloudy
 9. Wind 0-10 0-10 0-10 0-10
 10. Temp 25.0 25.0 25.0 25.0
 11. Humidity 80 80 80 80
 12. Pressure 1010 1010 1010 1010
 13. Soil Loam Loam Loam Loam
 14. Vegetation Forest Forest Forest Forest
 15. Notes See field notes See field notes See field notes See field notes

BORING W4-3

STATION				DATE		TIME		WIND		TEMP.		HUMIDITY		PRESSURE		SEA		SKY		REMARKS	
NAME				NO.		HOUR		DIRECTION		SURFACE		SEA LEVEL		AT 1000 FT.		WIND		CLOUDS		OTHER	
LATITUDE				LONGITUDE		LOCAL TIME		WIND		TEMP.		HUMIDITY		PRESSURE		SEA		SKY		REMARKS	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11											

BORING 15

[illegible]

Prof. Dr. Josef Kitzlerle at 445 North

NOTE:

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

			COMMONWEALTH OF VIRGINIA			
			DEPARTMENT OF HIGHWAYS AND TRANSPORTATION			
			RETAINING WALL 4			
			BORING LOGS			
No.	Description	Date	Designed by	Date	Plan No.	Sheet No.
			Drawn by <i>JGV</i>	<i>Sept. 5, 1985</i>	<i>05 9</i>	<i>18 45 of 52</i>
	Revisions		Checked by <i>WBA</i>			

BORING 15A

80RING W-22

BORING WS-1

BORING W5-2

BORING W5-3

BORING 11

[illegible][illegible][illegible][illegible]

LOCALITY AND DATE		SAMPLING METHOD		ANALYSIS	
NO.	DATE	TIME	DEPTH	TEMP.	WIND
1	1900	10.0	10.0	10.0	10.0
2	1901	10.1	10.1	10.1	10.1
3	1902	10.2	10.2	10.2	10.2
4	1903	10.3	10.3	10.3	10.3
5	1904	10.4	10.4	10.4	10.4
6	1905	10.5	10.5	10.5	10.5
7	1906	10.6	10.6	10.6	10.6
8	1907	10.7	10.7	10.7	10.7
9	1908	10.8	10.8	10.8	10.8
10	1909	10.9	10.9	10.9	10.9
11	1910	11.0	11.0	11.0	11.0
12	1911	11.1	11.1	11.1	11.1
13	1912	11.2	11.2	11.2	11.2
14	1913	11.3	11.3	11.3	11.3
15	1914	11.4	11.4	11.4	11.4
16	1915	11.5	11.5	11.5	11.5
17	1916	11.6	11.6	11.6	11.6
18	1917	11.7	11.7	11.7	11.7
19	1918	11.8	11.8	11.8	11.8
20	1919	11.9	11.9	11.9	11.9
21	1920	12.0	12.0	12.0	12.0
22	1921	12.1	12.1	12.1	12.1
23	1922	12.2	12.2	12.2	12.2
24	1923	12.3	12.3	12.3	12.3
25	1924	12.4	12.4	12.4	12.4
26	1925	12.5	12.5	12.5	12.5
27	1926	12.6	12.6	12.6	12.6
28	1927	12.7	12.7	12.7	12.7
29	1928	12.8	12.8	12.8	12.8
30	1929	12.9	12.9	12.9	12.9
31	1930	13.0	13.0	13.0	13.0
32	1931	13.1	13.1	13.1	13.1
33	1932	13.2	13.2	13.2	13.2
34	1933	13.3	13.3	13.3	13.3
35	1934	13.4	13.4	13.4	13.4
36	1935	13.5	13.5	13.5	13.5
37	1936	13.6	13.6	13.6	13.6
38	1937	13.7	13.7	13.7	13.7
39	1938	13.8	13.8	13.8	13.8
40	1939	13.9	13.9	13.9	13.9
41	1940	14.0	14.0	14.0	14.0
42	1941	14.1	14.1	14.1	14.1
43	1942	14.2	14.2	14.2	14.2
44	1943	14.3	14.3	14.3	14.3
45	1944	14.4	14.4	14.4	14.4
46	1945	14.5	14.5	14.5	14.5
47	1946	14.6	14.6	14.6	14.6
48	1947	14.7	14.7	14.7	14.7
49	1948	14.8	14.8	14.8	14.8
50	1949	14.9	14.9	14.9	14.9
51	1950	15.0	15.0	15.0	15.0
52	1951	15.1	15.1	15.1	15.1
53	1952	15.2	15.2	15.2	15.2
54	1953	15.3	15.3	15.3	15.3
55	1954	15.4	15.4	15.4	15.4
56	1955	15.5	15.5	15.5	15.5
57	1956	15.6	15.6	15.6	15.6
58	1957	15.7	15.7	15.7	15.7
59	1958	15.8	15.8	15.8	15.8
60	1959	15.9	15.9	15.9	15.9
61	1960	16.0	16.0	16.0	16.0
62	1961	16.1	16.1	16.1	16.1

[illegible]

NOTE:

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

			COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION			
			RETAINING WALLS 4 AND 5			
			BORING LOGS			
No.	Description	Date	Designed By	Date	Plan No.	Sheet No.
			Drawn By <u>WAK</u>	<u>Sept. 5, 1985</u>	<u>85 9</u>	<u>46 of 52</u>
	Revisions		Checked by <u>WBA</u>			

BORING W-20

COUNTY		PROJECT		DATE		BY		CHECKED	
Stafford		Retaining Walls 6 & 7		10/1/85		J. G. W.		J. G. W.	
BORING NO.		W-20		DATE		BY		CHECKED	
1		2		3		4		5	
6		7		8		9		10	
11		12		13		14		15	
16		17		18		19		20	
21		22		23		24		25	
26		27		28		29		30	
31		32		33		34		35	
36		37		38		39		40	
41		42		43		44		45	
46		47		48		49		50	
51		52		53		54		55	
56		57		58		59		60	
61		62		63		64		65	
66		67		68		69		70	
71		72		73		74		75	
76		77		78		79		80	
81		82		83		84		85	
86		87		88		89		90	
91		92		93		94		95	
96		97		98		99		100	
101		102		103		104		105	
106		107		108		109		110	
111		112		113		114		115	
116		117		118		119		120	
121		122		123		124		125	
126		127		128		129		130	
131		132		133		134		135	
136		137		138		139		140	
141		142		143		144		145	
146		147		148		149		150	
151		152		153		154		155	
156		157		158		159		160	
161		162		163		164		165	
166		167		168		169		170	
171		172		173		174		175	
176		177		178		179		180	
181		182		183		184		185	
186		187		188		189		190	
191		192		193		194		195	
196		197		198		199		200	
201		202		203		204		205	
206		207		208		209		210	
211		212		213		214		215	
216		217		218		219		220	
221		222		223		224		225	
226		227		228		229		230	
231		232		233		234		235	
236		237		238		239		240	
241		242		243		244		245	
246		247		248		249		250	
251		252		253		254		255	
256		257		258		259		260	
261		262		263		264		265	
266		267		268		269		270	
271		272		273		274		275	
276		277		278		279		280	
281		282		283		284		285	
286		287		288		289		290	
291		292		293		294		295	
296		297		298		299		300	
301		302		303		304		305	
306		307		308		309		310	
311		312		313		314		315	
316		317		318		319		320	
321		322		323		324		325	
326		327		328		329		330	
331		332		333		334		335	
336		337		338		339		340	
341		342		343		344		345	
346		347		348		349		350	
351		352		353		354		355	
356		357		358		359		360	
361		362		363		364		365	
366		367		368		369		370	
371		372		373		374		375	
376		377		378		379		380	
381		382		383		384		385	
386		387		388		389		390	
391		392		393		394		395	
396		397		398		399		400	
401		402		403		404		405	
406		407		408		409		410	
411		412		413		414		415	
416		417		418		419		420	
421		422		423		424		425	
426		427		428		429		430	
431		432		433		434		435	
436		437		438		439		440	
441		442							

BORING 5

[illegible]

BOILING 6

Date		Description		Amount		Balance	
Month	Day	Particulars	To	By	Balance	Forward	
Jan	1	Balance b/d	100.00		100.00		
Jan	2	By Cash	50.00		150.00		
Jan	3	To Cash		20.00	130.00		
Jan	4	By Cash	30.00		160.00		
Jan	5	To Cash		10.00	150.00		
Jan	6	By Cash	40.00		190.00		
Jan	7	To Cash		25.00	165.00		
Jan	8	By Cash	60.00		225.00		
Jan	9	To Cash		15.00	210.00		
Jan	10	By Cash	70.00		280.00		
Jan	11	To Cash		30.00	250.00		
Jan	12	By Cash	80.00		330.00		
Jan	13	To Cash		20.00	310.00		
Jan	14	By Cash	90.00		400.00		
Jan	15	To Cash		10.00	390.00		
Jan	16	By Cash	100.00		490.00		
Jan	17	To Cash		25.00	465.00		
Jan	18	By Cash	110.00		575.00		
Jan	19	To Cash		15.00	560.00		
Jan	20	By Cash	120.00		680.00		
Jan	21	To Cash		30.00	650.00		
Jan	22	By Cash	130.00		780.00		
Jan	23	To Cash		20.00	760.00		
Jan	24	By Cash	140.00		900.00		
Jan	25	To Cash		10.00	890.00		
Jan	26	By Cash	150.00		1040.00		
Jan	27	To Cash		25.00	1015.00		
Jan	28	By					

BORING #7-4

[illegible]

BORING 7

[illegible]

BORING W7-3

COUNTY ORGANIZATION				VALUATION, PERSONAL PROPERTY TAXES			
1917				1918			
1919				1920			
1921				1922			
1923				1924			
1925				1926			
1927				1928			
1929				1930			
1931				1932			
1933				1934			
1935				1936			
1937				1938			
1939				1940			
1941				1942			
1943				1944			
1945				1946			
1947				1948			
1949				1950			
1951				1952			
1953				1954			
1955				1956			
1957				1958			
1959				1960			
1961				1962			
1963				1964			
1965				1966			
1967				1968			
1969				1970			
1971				1972			
1973				1974			
1975				1976			
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1979				1980			
1981				1982			
1983				1984			
1985				1986			
1987				1988			
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2159				2160			
2161				21			

BORING 1

[illegible]

NOTE:

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

			COMMONWEALTH OF VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION			
			RETAINING WALLS 7 AND 8			
			BORING LOGS			
No.	Description	Date	Designed by	Date	Plan No.	Cust? No.
	Revisions		Drawn by AGV Checked by WBA	Sept. 5, 1985	65	48 of 52

BORING W8-1

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. W8-1		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

Notes:
 (1) Hole closed after 20 ft depth.
 (2) No encountered water.

BORING W-24

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. W-24		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

BORING W-25

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. W-25		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

BORING W8-2

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. W8-2		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

Notes:
 (1) No recovery in sample #9.
 (2) No recovery in sample #10.
 (3) No recovery in sample #11.
 (4) No recovery in sample #12.
 (5) No recovery in sample #13.
 (6) No recovery in sample #14.
 (7) No recovery in sample #15.
 (8) No recovery in sample #16.
 (9) No recovery in sample #17.
 (10) No recovery in sample #18.
 (11) No recovery in sample #19.
 (12) No recovery in sample #20.

BORING 10

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. 10		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

BORING 10A

COUNTY: Arlington		NATIONAL HIGHWAY: 267	
PROJECT NO. 0001-000-105, C-501		DATE: 10/1/85	
BORING NO. 10A		DEPTH: 20.0	
LOCATION: 1/2 mile S of 267, 1/2 mile E of 267		SUBMITTED BY: J. E. Smith	
DATE: 10/1/85		REMARKS:	
FORMATION	DEPTH (ft)	DEPTH (ft)	REMARKS
CLAY	0.0	0.0	
CLAY	1.0	1.0	
CLAY	2.0	2.0	
CLAY	3.0	3.0	
CLAY	4.0	4.0	
CLAY	5.0	5.0	
CLAY	6.0	6.0	
CLAY	7.0	7.0	
CLAY	8.0	8.0	
CLAY	9.0	9.0	
CLAY	10.0	10.0	
CLAY	11.0	11.0	
CLAY	12.0	12.0	
CLAY	13.0	13.0	
CLAY	14.0	14.0	
CLAY	15.0	15.0	
CLAY	16.0	16.0	
CLAY	17.0	17.0	
CLAY	18.0	18.0	
CLAY	19.0	19.0	
CLAY	20.0	20.0	

NOTE:

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COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS AND TRANSPORTATION

RETAINING WALLS 8 AND 9

BORING LOGS

No.	Description	Date	Designed by	Drawn by	Checked by	Plan No.	Sheet No.
1	Retaining Wall	Sept 5, 1985	J. E. Smith	J. E. Smith	J. E. Smith	105-9-18	49 of 52

BORING WS-2

BORING W9-3

BORING W-30

BGRING WS-4

BORING W-31

BORING W-32

[illegible][illegible]

PERSONAL INFORMATION				EMPLOYMENT INFORMATION				EDUCATION				MILITARY SERVICE				CRIMINAL RECORD				FINANCIAL INFORMATION				OTHER INFORMATION			
NAME	DATE OF BIRTH	SEX	SSN	POSITION	EMPLOYER	START DATE	END DATE	SCHOOL	DEGREE	START DATE	END DATE	BRANCH	GRADE	CRIMINAL RECORD	FINANCIAL INFORMATION	OTHER INFORMATION	FINANCIAL INFORMATION	OTHER INFORMATION	FINANCIAL INFORMATION	OTHER INFORMATION	FINANCIAL INFORMATION	OTHER INFORMATION					
John Doe	1980-01-15	M	123-45-6789	Secretary	ABC Company	2002-01-01	2003-12-31	High School	High School	Army	Private	1998-01-01	2000-12-31	None	\$10,000	None	\$10,000	None	\$10,000	None	\$10,000	None					
Jane Smith	1985-03-22	F	987-65-4321	Manager	XYZ Corp	2004-01-01	2005-12-31	College	Bachelor's	Navy	Seaman	2001-01-01	2002-12-31	1 Year	\$20,000	1 Year	\$20,000	1 Year	\$20,000	1 Year	\$20,000	1 Year					
Bob Johnson	1978-07-10	M	555-44-3322	Engineer	DEF Inc	2003-01-01	2004-12-31	University	Master's	Air Force	Major	1999-01-01	2001-12-31	2 Years	\$30,000	2 Years	\$30,000	2 Years	\$30,000	2 Years	\$30,000	2 Years					
Alice Brown	1990-11-05	F	111-22-3344	Analyst	GHI LLC	2005-01-01	2006-12-31	College	Bachelor's	Marine Corps	Sergeant	2002-01-01	2003-12-31	3 Years	\$15,000	3 Years	\$15,000	3 Years	\$15,000	3 Years	\$15,000	3 Years					
Charlie Davis	1982-04-18	M	666-77-8899	Developer	JKL Systems	2006-01-01	2007-12-31	University	PhD	Civilian	None	None	None	None	\$40,000	None	\$40,000	None	\$40,000	None	\$40,000	None					
Eve White	1975-09-01	F	333-44-5566	Teacher	MNO Education	2001-01-01	2002-12-31	College	Bachelor's	Army	Private	1997-01-01	1998-12-31	None	\$12,000	None	\$12,000	None	\$12,000	None	\$12,000	None					
Frank Green	1988-06-25	M	777-88-9900	Salesman	PQR Sales	2007-01-01	2008-12-31	High School	High School	Navy	Seaman	2004-01-01	2005-12-31	1 Year	\$18,000	1 Year	\$18,000	1 Year	\$18,000	1 Year	\$18,000	1 Year					
Grace Black	1979-12-12	F	444-55-6677	Designer	RST Design	2002-01-01	2003-12-31	College	Bachelor's	Air Force	Major	1999-01-01	2000-12-31	2 Years	\$25,000	2 Years	\$25,000	2 Years	\$25,000	2 Years	\$25,000	2 Years					
Henry Gold	1983-08-03	M	222-33-4455	Programmer	UVW Tech	2008-01-01	2009-12-31	University	Master's	Civilian	None	None	None	None	\$35,000	None	\$35,000	None	\$35,000	None	\$35,000	None					
Ivy Silver	1987-02-14	F	888-99-0011	Writer	XYZ Media	2009-01-01	2010-12-31	College	Bachelor's	Marine Corps	Sergeant	2005-01-01	2006-12-31	3 Years	\$16,000	3 Years	\$16,000	3 Years	\$16,000	3 Years	\$16,000	3 Years					
Jack Copper	1976-05-20	M	555-66-7788	Engineer	DEF Inc	2000-01-01	2001-12-31	University	PhD	Civilian	None	None	None	None	\$45,000	None	\$45,000	None	\$45,000	None	\$45,000	None					
Karen Bronze	1981-10-07	F	111-22-3344	Manager	GHI LLC	2003-01-01	2004-12-31	College	Bachelor's	Army	Private	1998-01-01	1999-12-31	None	\$14,000	None	\$14,000	None	\$14,000	None	\$14,000	None					
Leo Nickel	1984-03-28	M	666-77-8899	Analyst	JKL Systems	2006-01-01	2007-12-31	University	Master's	Navy	Seaman	2004-01-01	2005-12-31	1 Year	\$22,000	1 Year	\$22,000	1 Year	\$22,000	1 Year	\$22,000	1 Year					
Mia Zinc	1977-07-19	F	333-44-5566	Designer	RST Design	2001-01-01	2002-12-31	College	Bachelor's	Air Force	Major	1997-01-01	1998-12-31	2 Years	\$28,000	2 Years	\$28,000	2 Years	\$28,000	2 Years	\$28,000	2 Years					
Noah Lead	1986-11-04	M	777-88-9900	Programmer	UVW Tech	2008-01-01	2009-12-31	University	PhD	Civilian	None	None	None	None	\$38,000	None	\$38,000	None	\$38,000	None	\$38,000	None					
Olivia Tin	1980-04-21	F	444-55-6677	Writer	XYZ Media	2009-01-01	2010-12-31	College	Bachelor's	Marine Corps	Sergeant	2005-01-01	2006-12-31	3 Years	\$17,000	3 Years	\$17,000	3 Years	\$17,000	3 Years	\$17,000	3 Years					
Peter Silver	1978-09-08	M	222-33-4455	Engineer	DEF Inc	2000-01-01	2001-12-31	University	PhD	Civilian	None	None	None	None	\$42,000	None	\$42,000	None	\$42,000	None	\$42,000	None					
Quinn Gold	1982-12-16	F	888-99-0011	Manager	GHI LLC	2003-01-01	2004-12-31	College	Bachelor's	Army	Private	1998-01-01	1999-12-31	None	\$13,000	None	\$13,000	None	\$13,000	None	\$13,000	None					
Sam Copper	1985-06-02	M	555-66-7788	Analyst	JKL Systems	2006-01-01	2007-12-31	University	Master's	Navy	Seaman	2004-01-01	2005-12-31	1 Year	\$21,000	1 Year	\$21,000	1 Year	\$21,000	1 Year	\$21,000	1 Year					
Tina Nickel	1979-01-23	F	111-22-3344	Designer	RST Design	2001-01-01	2002-12-31	College	Bachelor's	Air Force	Major	1997-01-01	1998-12-31	2 Years	\$26,000	2 Years	\$26,000	2 Years	\$26,000	2 Years	\$26,000	2 Years					
Uma Zinc	1983-05-11	F	666-77-8899	Programmer	UVW Tech	2008-01-01	2009-12-31	University	PhD	Civilian	None	None	None	None	\$36,000	None	\$36,000	None	\$36,000	None	\$36,000	None					
Victor Lead	1987-09-27	M	333-44-5566	Writer	XYZ Media	2009-01-01	2010-12-31	College	Bachelor's	Marine Corps	Sergeant	2005-01-01	2006-12-31	3 Years	\$19,000	3 Years	\$19,000	3 Years	\$19,000	3 Years	\$19,000	3 Years					
Wendy Tin	1976-03-05	F	777-88-9900	Engineer	DEF Inc	2000-01-01	2001-12-31	University	PhD	Civilian	None	None	None	None	\$41,000	None	\$41,000	None	\$41,000	None	\$41,000	None					
Xavier Gold	1981-07-13	M	444-55-6677	Manager	GHI LLC	2003-01-01	2004-12-31	College	Bachelor's	Army	Private	1998-01-01	1999-12-31	None	\$11,000	None	\$11,000	None	\$11,000	None	\$11,000	None					
Yara Copper	1984-11-29	F	222-33-4455	Analyst	JKL Systems	2006-01-01	2007-12-31	University	Master's	Navy	Seaman	2004-01-01	2005-12-31	1 Year	\$23,000	1 Year	\$23,000	1 Year	\$23,000	1 Year	\$23,000	1 Year					
Zoe Nickel	1978-04-06	F	888-99-0011	Designer	RST Design	2001-01-01	2002-12-31	College	Bachelor's	Air Force	Major	1997-01-01	1998-12-31	2 Years	\$27,000	2 Years	\$27,000	2 Years	\$27,000	2 Years	\$27,000	2 Years					

CONTAINER INFORMATION		CONTAINER NO.		CONTAINER TYPE		CONTAINER STATUS		CONTAINER LOCATION		CONTAINER DATE		CONTAINER TIME		CONTAINER USER		CONTAINER COMMENTS	
CONTAINER NO.	CONTAINER TYPE	CONTAINER STATUS	CONTAINER LOCATION	CONTAINER DATE	CONTAINER TIME	CONTAINER USER	CONTAINER COMMENTS	CONTAINER NO.	CONTAINER TYPE	CONTAINER STATUS	CONTAINER LOCATION	CONTAINER DATE	CONTAINER TIME	CONTAINER USER	CONTAINER COMMENTS	CONTAINER NO.	CONTAINER TYPE
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
27	27	27	27</														

[illegible][illegible]

NOTES

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

			COMMONWEALTH OF VIRGINIA			
			DEPARTMENT OF HIGHWAYS AND TRANSPORTATION			
			RETAINING WALL 9			
			BORING LOGS			
No.	Description	Date	Designed by	Date	Plan No.	Sheet No.
	Revisions		Drawn by HAY	Sept. 5, 1985	65 9	50 of 52
			Checked by WBA		1	

BORING W-29

[illegible]

BORING 22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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BORING 23

1. NAME OF THE VESSEL		2. NAME OF THE MASTER		3. NAME OF THE CAPTAIN		4. NAME OF THE COMMANDER		5. NAME OF THE SURVEILLANT		6. NAME OF THE OBSERVER		7. NAME OF THE RESEARCHER		8. NAME OF THE ASSISTANT		9. NAME OF THE DRIVER		10. NAME OF THE ENGINEER		11. NAME OF THE MECHANIC		12. NAME OF THE ELECTRICIAN		13. NAME OF THE RADIO OPERATOR		14. NAME OF THE TELETYPE OPERATOR		15. NAME OF THE TELEPHONE OPERATOR		16. NAME OF THE TELEGRAPH OPERATOR		17. NAME OF THE TELEVISION OPERATOR		18. NAME OF THE PHOTOGRAPHIC OPERATOR		19. NAME OF THE FILM OPERATOR		20. NAME OF THE DEVELOPER		21. NAME OF THE PRINT OPERATOR		22. NAME OF THE MOUNT OPERATOR		23. NAME OF THE SLIDE OPERATOR		24. NAME OF THE MICROSCOPE OPERATOR		25. NAME OF THE X-RAY OPERATOR		26. NAME OF THE RADIATION OPERATOR		27. NAME OF THE THERMIST OPERATOR		28. NAME OF THE THERMIST OPERATOR		29. NAME OF THE THERMIST OPERATOR		30. NAME OF THE THERMIST OPERATOR		31. NAME OF THE THERMIST OPERATOR		32. NAME OF THE THERMIST OPERATOR		33. NAME OF THE THERMIST OPERATOR		34. NAME OF THE THERMIST OPERATOR		35. NAME OF THE THERMIST OPERATOR		36. NAME OF THE THERMIST OPERATOR		37. NAME OF THE THERMIST OPERATOR		38. NAME OF THE THERMIST OPERATOR		39. NAME OF THE THERMIST OPERATOR		40. NAME OF THE THERMIST OPERATOR		41. NAME OF THE THERMIST OPERATOR		42. NAME OF THE THERMIST OPERATOR		43. NAME OF THE THERMIST OPERATOR		44. NAME OF THE THERMIST OPERATOR		45. NAME OF THE THERMIST OPERATOR		46. NAME OF THE THERMIST OPERATOR		47. NAME OF THE THERMIST OPERATOR		48. NAME OF THE THERMIST OPERATOR		49. NAME OF THE THERMIST OPERATOR		50. NAME OF THE THERMIST OPERATOR		51. NAME OF THE THERMIST OPERATOR		52. NAME OF THE THERMIST OPERATOR		53. NAME OF THE THERMIST OPERATOR		54. NAME OF THE THERMIST OPERATOR		55. NAME OF THE THERMIST OPERATOR		56. NAME OF THE THERMIST OPERATOR		57. NAME OF THE THERMIST OPERATOR		58. NAME OF THE THERMIST OPERATOR		59. NAME OF THE THERMIST OPERATOR		60. NAME OF THE THERMIST OPERATOR		61. NAME OF THE THERMIST OPERATOR		62. NAME OF THE THERMIST OPERATOR		63. NAME OF THE THERMIST OPERATOR		64. NAME OF THE THERMIST OPERATOR		65. NAME OF THE THERMIST OPERATOR		66. NAME OF THE THERMIST OPERATOR		67. NAME OF THE THERMIST OPERATOR		68. NAME OF THE THERMIST OPERATOR		69. NAME OF THE THERMIST OPERATOR		70. NAME OF THE THERMIST OPERATOR		71. NAME OF THE THERMIST OPERATOR		72. NAME OF THE THERMIST OPERATOR		73. NAME OF THE THERMIST OPERATOR		74. NAME OF THE THERMIST OPERATOR		75. NAME OF THE THERMIST OPERATOR		76. NAME OF THE THERMIST OPERATOR		77. NAME OF THE THERMIST OPERATOR		78. NAME OF THE THERMIST OPERATOR		79. NAME OF THE THERMIST OPERATOR		80. NAME OF THE THERMIST OPERATOR		81. NAME OF THE THERMIST OPERATOR		82. NAME OF THE THERMIST OPERATOR		83. NAME OF THE THERMIST OPERATOR		84. NAME OF THE THERMIST OPERATOR		85. NAME OF THE THERMIST OPERATOR		86. NAME OF THE THERMIST OPERATOR		87. NAME OF THE THERMIST OPERATOR		88. NAME OF THE THERMIST OPERATOR		89. NAME OF THE THERMIST OPERATOR		90. NAME OF THE THERMIST OPERATOR		91. NAME OF THE THERMIST OPERATOR		92. NAME OF THE THERMIST OPERATOR		93. NAME OF THE THERMIST OPERATOR		94. NAME OF THE THERMIST OPERATOR		95. NAME OF THE THERMIST OPERATOR		96. NAME OF THE THERMIST OPERATOR		97. NAME OF THE THERMIST OPERATOR		98. NAME OF THE THERMIST OPERATOR		99. NAME OF THE THERMIST OPERATOR		100. NAME OF THE THERMIST OPERATOR	
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BORING 24

[illegible]

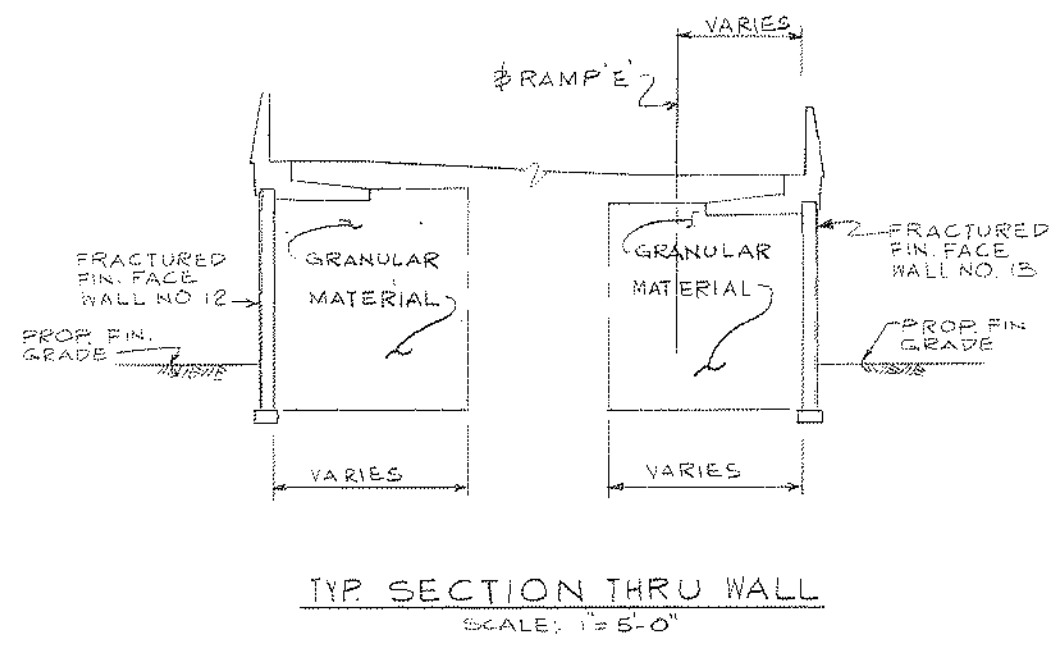
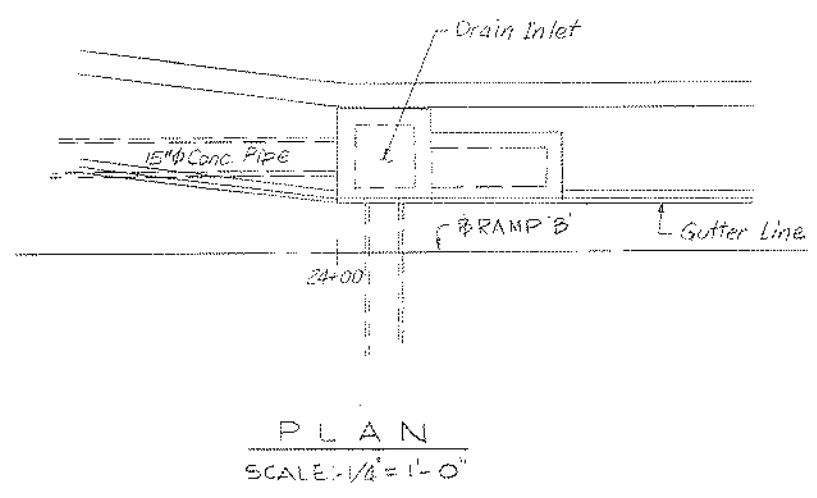
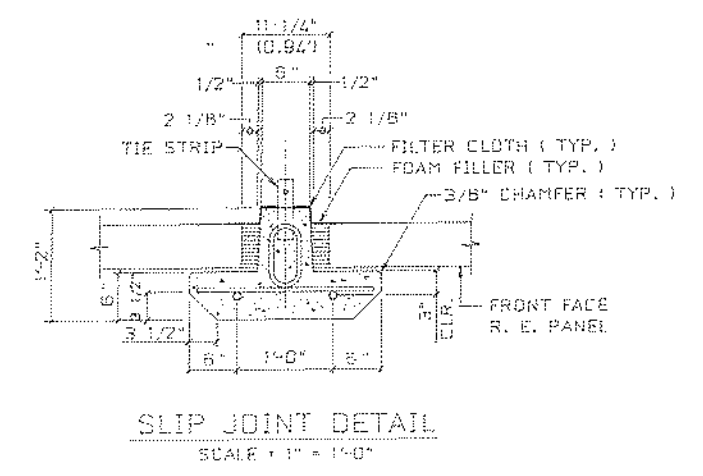
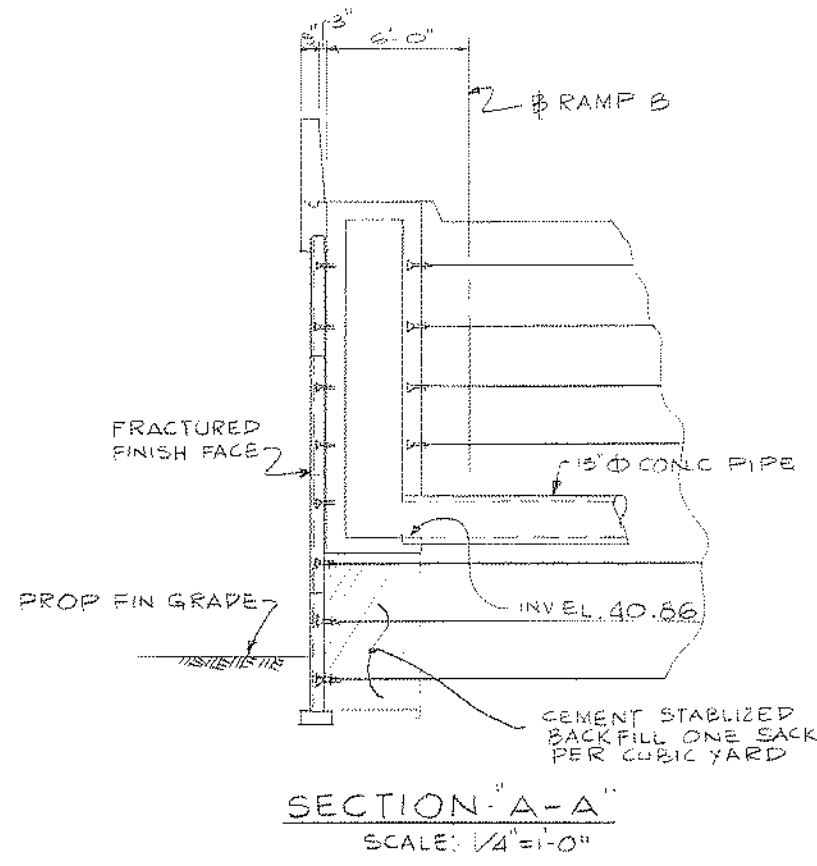
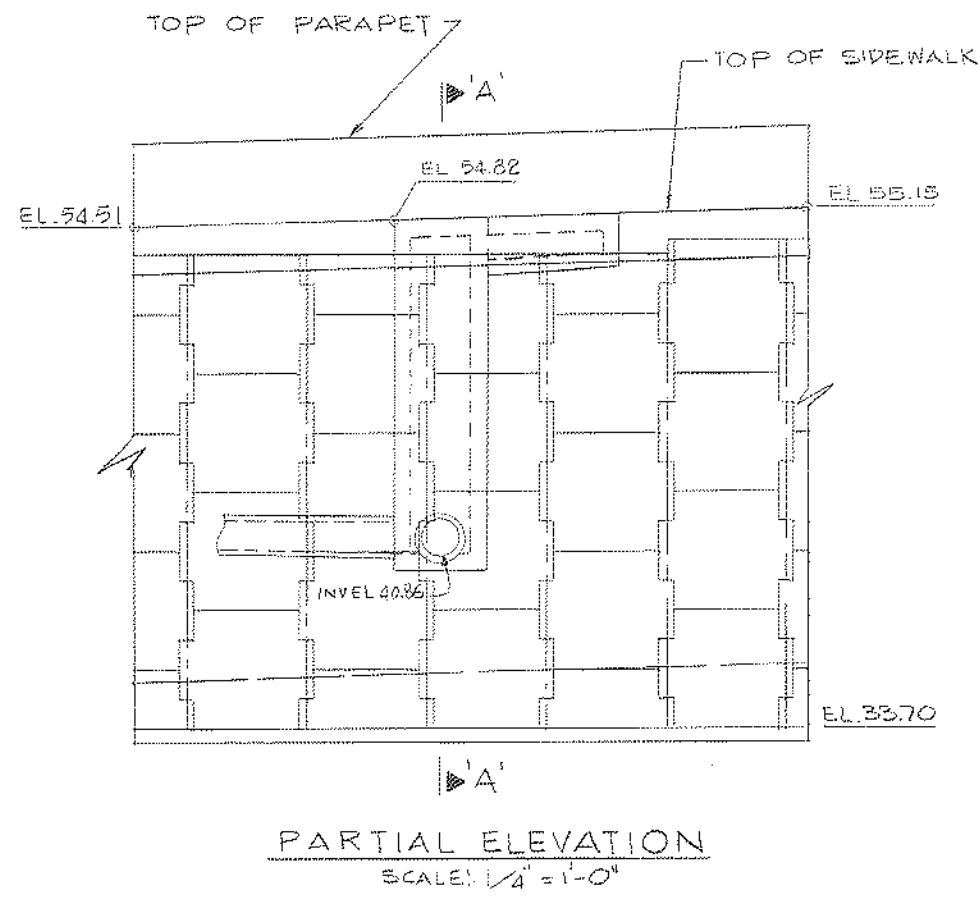
NOTE:

Subsurface information shown on this drawing was obtained solely for use in establishing design controls for the project. The accuracy of this information is not guaranteed and it is not to be construed as part of the plans governing construction of the project.

			COMMONWEALTH OF VIRGINIA			
			DEPARTMENT OF HIGHWAYS AND TRANSPORTATION			
			RETAINING WALLS 11,12 AND 13			
			BORING LOGS			
No.	Description	Date	Designed by	Date	Plan No.	Sheet No.
	Revisions		Drawn by JGH Checked By WBA	Sept-5, 1985	65 9	18 52 of 52

ATTACHMENT 4
MSE WALL TYPICAL SECTION
AND ELEVATION DRAWINGS BY
THE REINFORCED EARTH
COMPANY AND VSL
CORPORATION

REVISED	APPROVED	DATE	PROJECT	STATE	SHEET NO.
	3	VA		0001-000-105,0501	22A



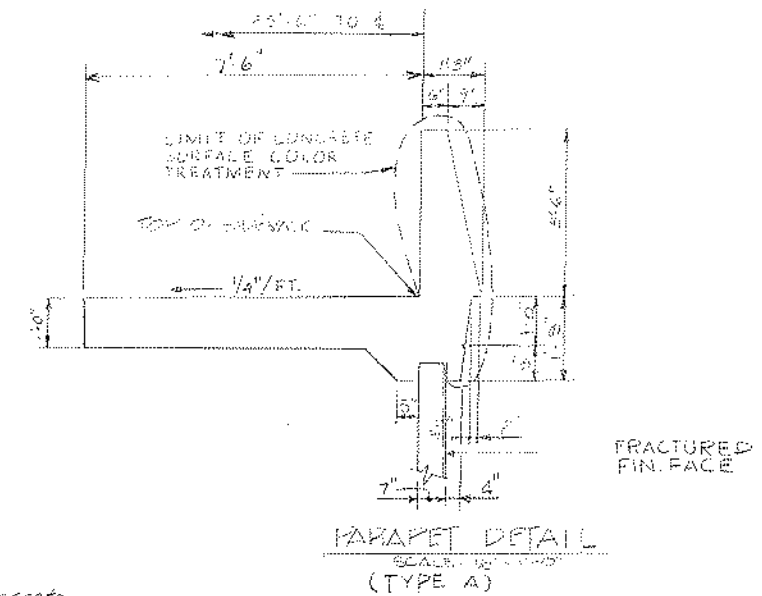
THE DESIGN CONTAINED ON THESE DRAWINGS IS BASED ON INFORMATION PROVIDED BY THE OWNER. ON THE BASIS OF THIS INFORMATION, THE REINFORCED EARTH COMPANY HAS DESIGNED, AND IS RESPONSIBLE FOR THE INTERNAL STABILITY OF THE STRUCTURE ONLY. EXTERNAL STABILITY, INCLUDING FOUNDATION AND SLOPE STABILITY, IS THE RESPONSIBILITY OF THE OWNER.

The Reinforced Earth Company
Rustlyn Center, 1700 North Moore Street, Arlington, Virginia 22209
(703) 591-3434

DESIGNED BY: J.S.
PROJ. ENGR: K.T.
CHECKED BY: K.T.
DATE: 10-12-85

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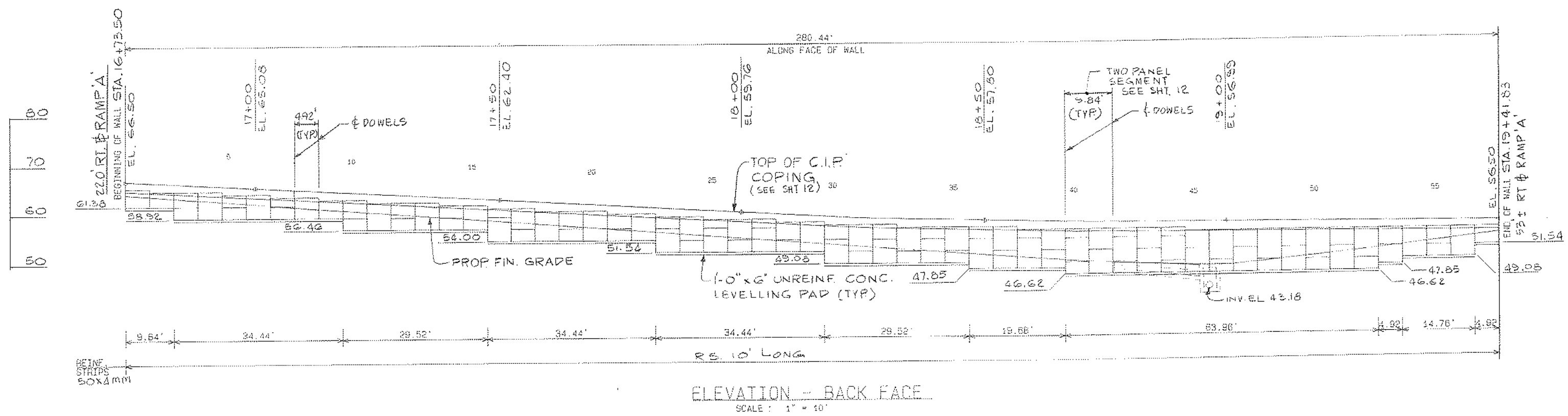


APPROX. SURFACE AREA= 3010 SQ. FT.

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Sheet No.	3	VA	0001-000-105,650	22A
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WALL NO. 5

APPROX. SURFACE AREA = 1790 SQ. FT.

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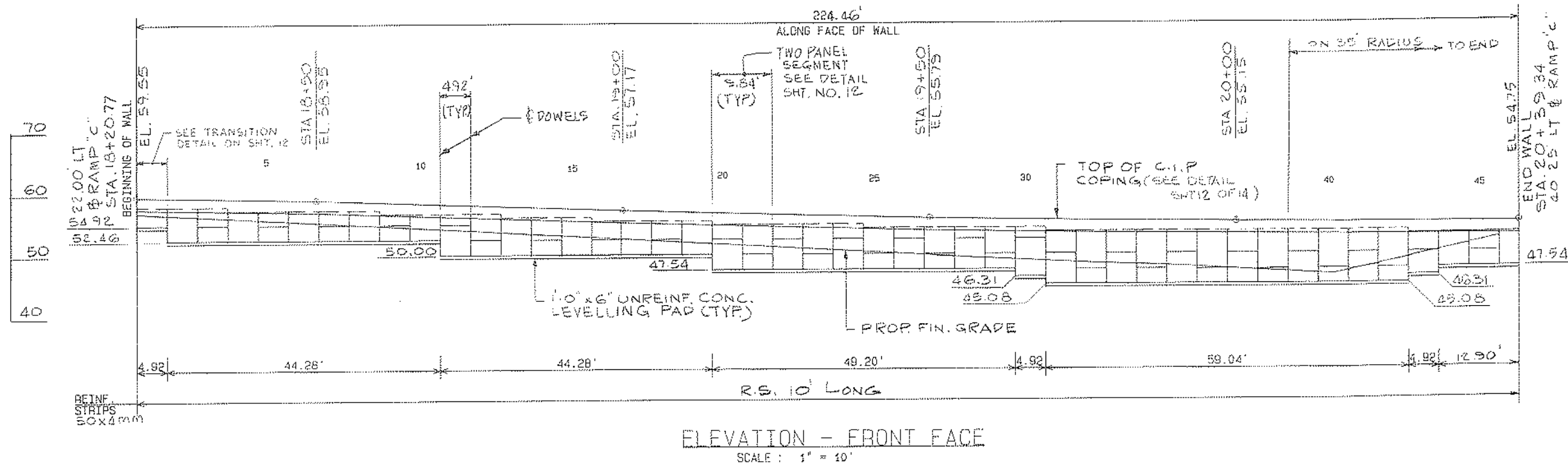
The Reinforced Earth Company
 Boxley Center, 1706 North Moore Street, Arlington, Virginia 22209
 (703) 527-3434

DESIGNED BY: JG
 PROJ. ENGR: KT
 CHECKED BY: KT
 DATE: 10-12-85

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WALL NO. 6

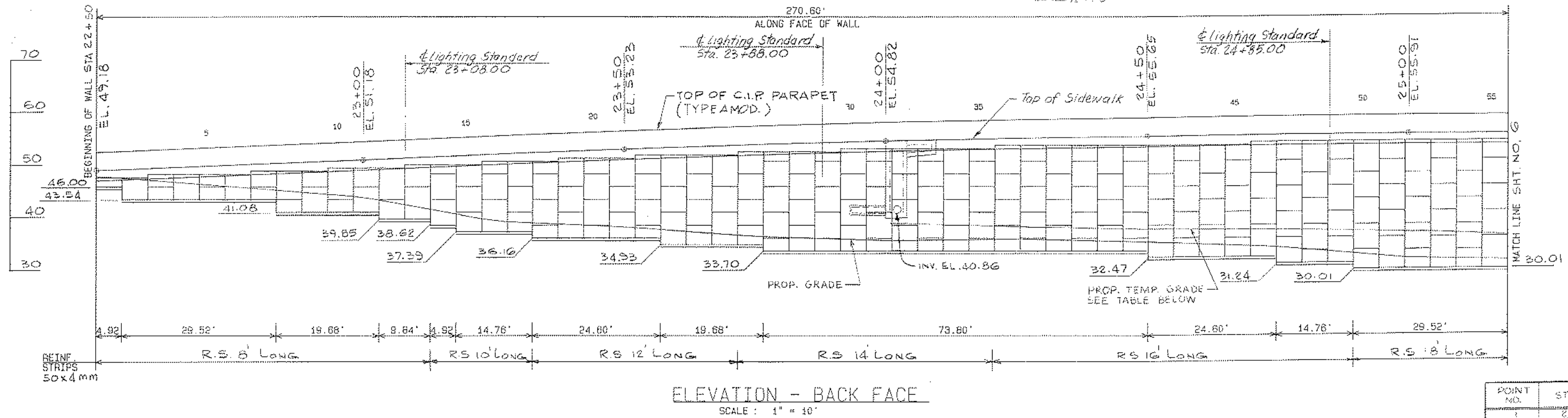
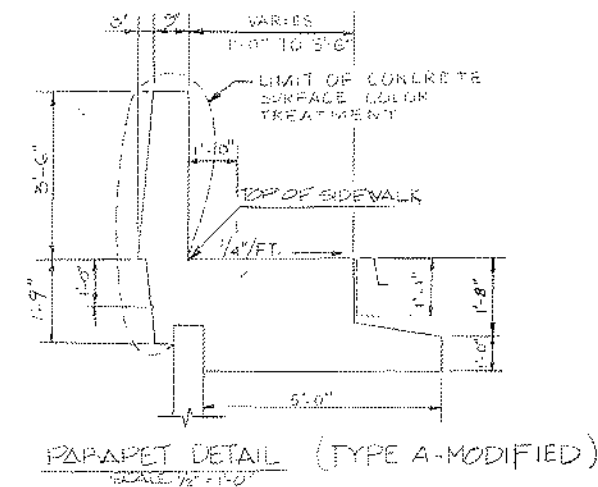
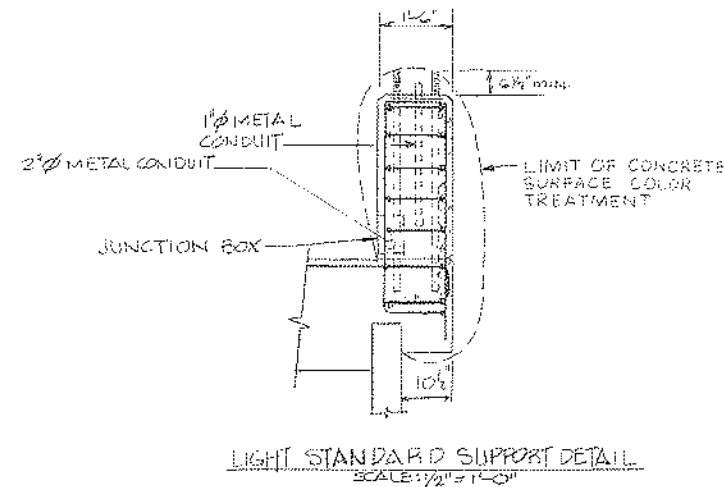
APPROX. SURFACE AREA = 1,400 SQ. FT.

THE DESIGN CONTAINED ON THESE DRAWINGS IS BASED ON INFORMATION PROVIDED BY THE OWNER. ON THE BASIS OF THIS INFORMATION, THE REINFORCED EARTH COMPANY HAS DESIGNED, AND IS RESPONSIBLE FOR THE INTERNAL STABILITY OF THE STRUCTURE ONLY. EXTERNAL STABILITY, INCLUDING FOUNDATION AND SLOPE STABILITY, IS THE RESPONSIBILITY OF THE OWNER.

The Reinforced Earth Company
Housley Center, 1700 North Moore Street, Arlington, Virginia 22209
(703) 927-3434

DESIGNED BY JS
PROJ. ENGR KT
CHECKED BY KT
DATE 10-12-85

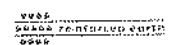
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WALL NO. 7

APPROX. SURFACE AREA = 16450 SQ. FT.

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The Reinforced Earth Company

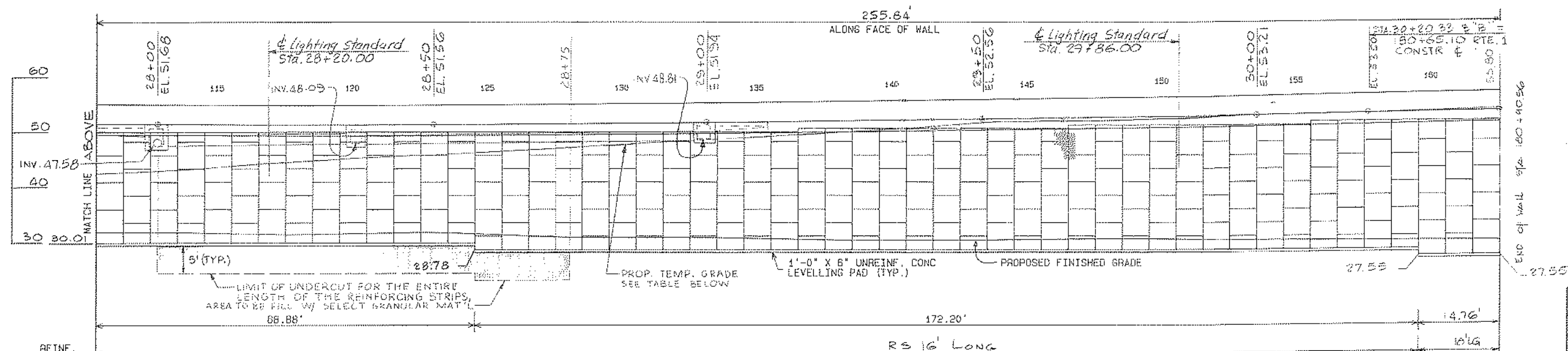
Head Office: 1701 North Main Street, Arlington, Virginia 22209
(703) 527-3434

DESIGNED BY JS.
PROJECT ENGINEER KT.
CHECKED BY KT.
DATE 10-12-85

"REINFORCED EARTH" IS THE REGISTERED TRADEMARK OF THE REINFORCED EARTH COMPANY.

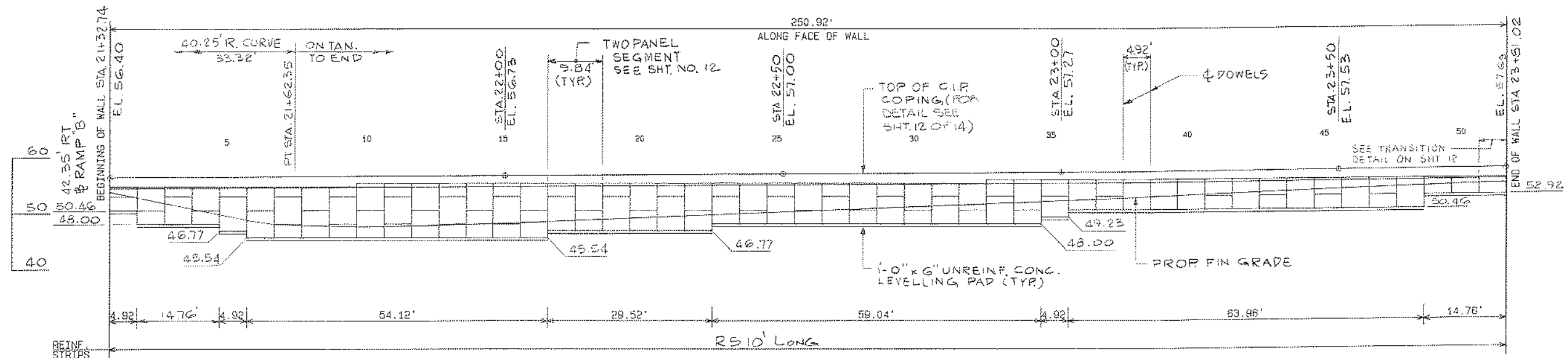
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POINT NO.	STATION	ELEVATION
1	24+01	38.60
2	24+26	37.90
3	24+51	37.20
4	24+76	37.00
5	25+01	36.20
6	25+26	35.50
7	25+51	35.30
8	25+76	35.40
9	26+01	35.80
10	26+27	35.90
11	26+52	35.70
12	26+77	37.50
13	27+02	37.90
14	27+27	38.80
15	27+52	40.00
16	27+77	41.60
17	28+02	42.30
18	28+27	44.10
19	28+52	45.50
20	28+77	47.00
21	29+02	48.80
22	29+28	49.50
23	29+53	51.20
24	29+78	51.50
25	30+03	52.50
26	30+77	53.20
27	31+02.56	53.50



WALL NO. 7

POINT NO.	STATION	ELEVATION
1	24+01	38.60
2	24+26	37.90
3	24+51	37.20
4	24+76	37.00
5	25+01	36.20
6	25+26	35.30
7	25+51	35.50
8	25+76	35.40
9	26+01	35.80
10	26+27	35.90
11	26+52	36.70
12	26+77	37.30
13	27+02	37.90
14	27+27	38.60
15	27+52	40.00
16	27+77	41.60
17	28+02	42.30
18	28+27	44.10
19	28+52	45.50
20	28+77	47.00
21	29+03	48.20
22	29+28	49.50
23	29+53	51.20
24	29+78	51.80
25	30+03	52.50
26	30+77	53.20
27	30+90.56	53.50



ELEVATION - BACK FACE

SCALE : 1" = 10'

WALL NO. 8

APPROX. SURFACE AREA = 1,665 SQ. FT.

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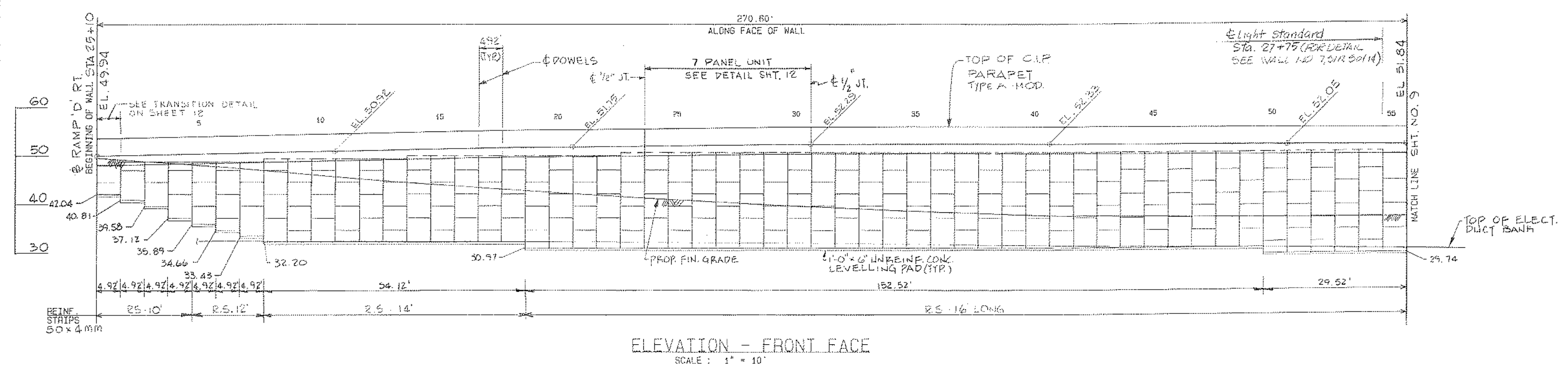
REINFORCED EARTH COMPANY

The Reinforced Earth Company
Ruralyn Center 1100 North Moore Street, Arlington, Virginia 22209
(703) 527-2434

DESIGNED BY	JS	DATE	10-12-85
PROJ. ENGR.	KT		
CHECKED BY	KT		

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WALL NO. 9

APPROX. SURFACE AREA = 13,480 SQ. FT.

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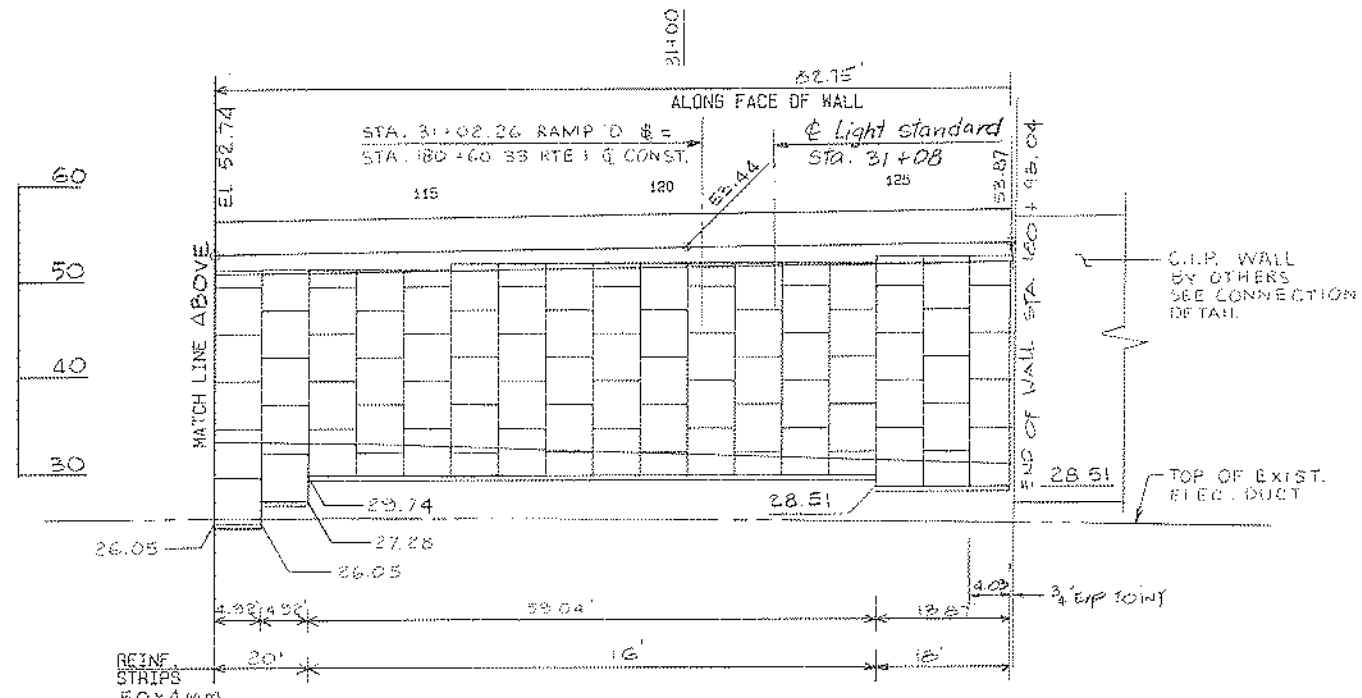
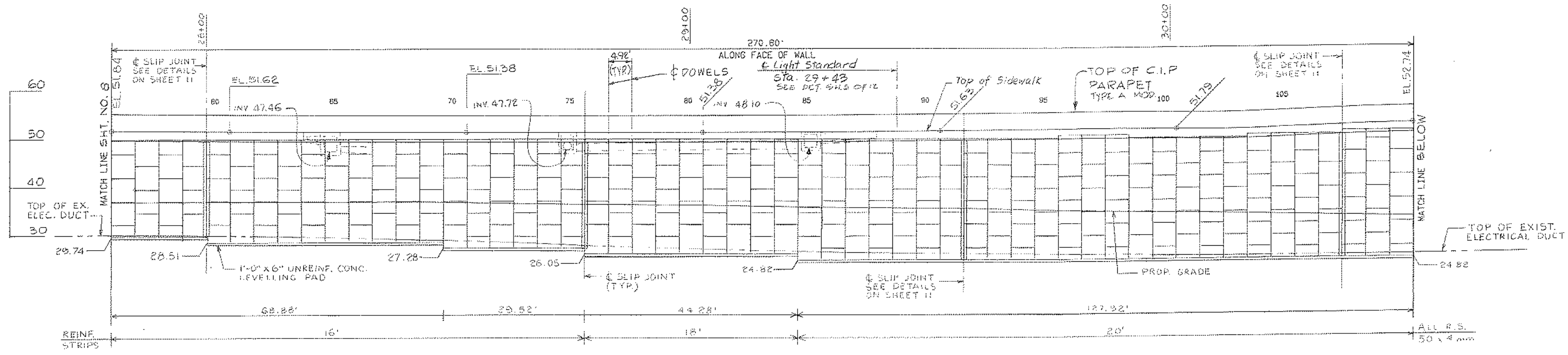
The Reinforced Earth Company
Raleigh, North Carolina 27601
1700 North Maple Street, Arlington, Virginia 22209
(703) 527-3434

DESIGNED BY J.S.
PROJ. ENGR. K.T.
CHECKED BY K.T.
DATE 10-12-85

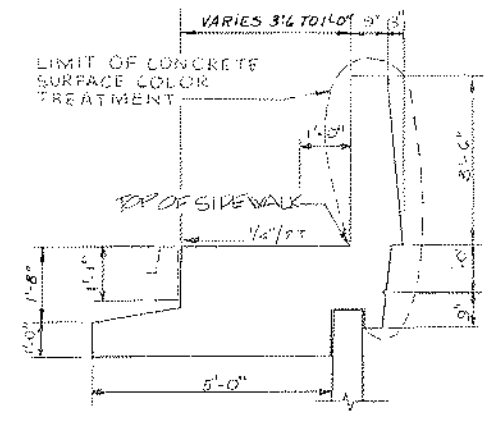
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26

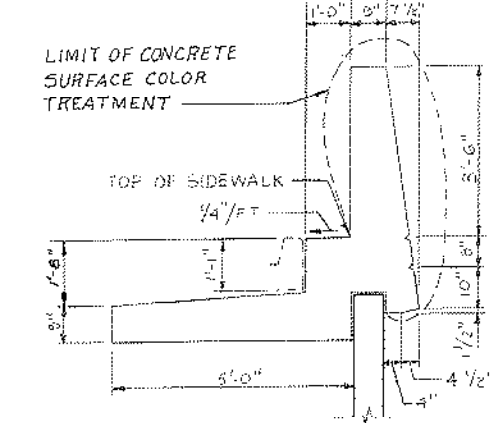
NO.	DATE	BY	PROJECT	STATION	REVISION
3	7/8	VA		0001-000-105, C501	22



ELEVATION - FRONT FACE
SCALE: 1" = 10'



PARAPET DETAIL
SCALE: 1/2" = 1'-0"
(TYPE A MODIFIED)



PARAPET DETAIL - NORTH END WALL 9
SCALE: 1/2" = 1'-0"
STA. 31+08 TO 180+93.04

WALL NO. 9

THE DESIGN CONTAINED ON THESE DRAWINGS IS BASED ON INFORMATION PROVIDED BY THE OWNER. ON THE BASIS OF THIS INFORMATION, THE REINFORCED EARTH COMPANY HAS DESIGNED, AND IS RESPONSIBLE FOR THE INTERNAL STABILITY OF THE STRUCTURE ONLY. EXTERNAL STABILITY, INCLUDING FOUNDATION AND SLOPE STABILITY, IS THE RESPONSIBILITY OF THE OWNER.

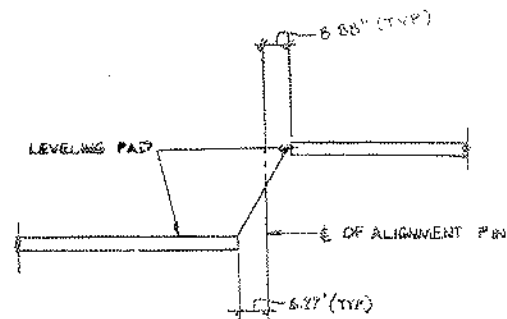
The Reinforced Earth Company
Rosedale, Canada, 1766 North Maple Street, Arlington, Virginia 22209
(703) 527-3400

DESIGNED BY: J.S.
MOD. ENGR: K.T.
CHECKED BY: K.T.
DATE: 10-12-85

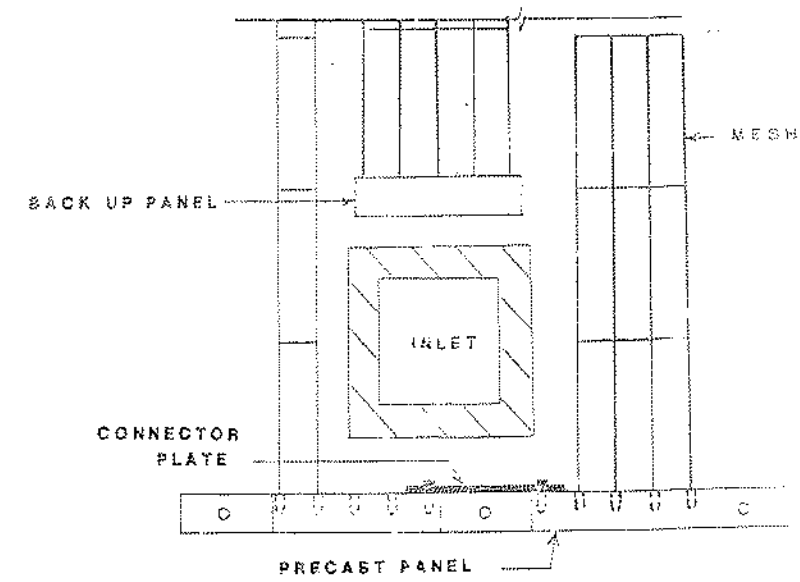
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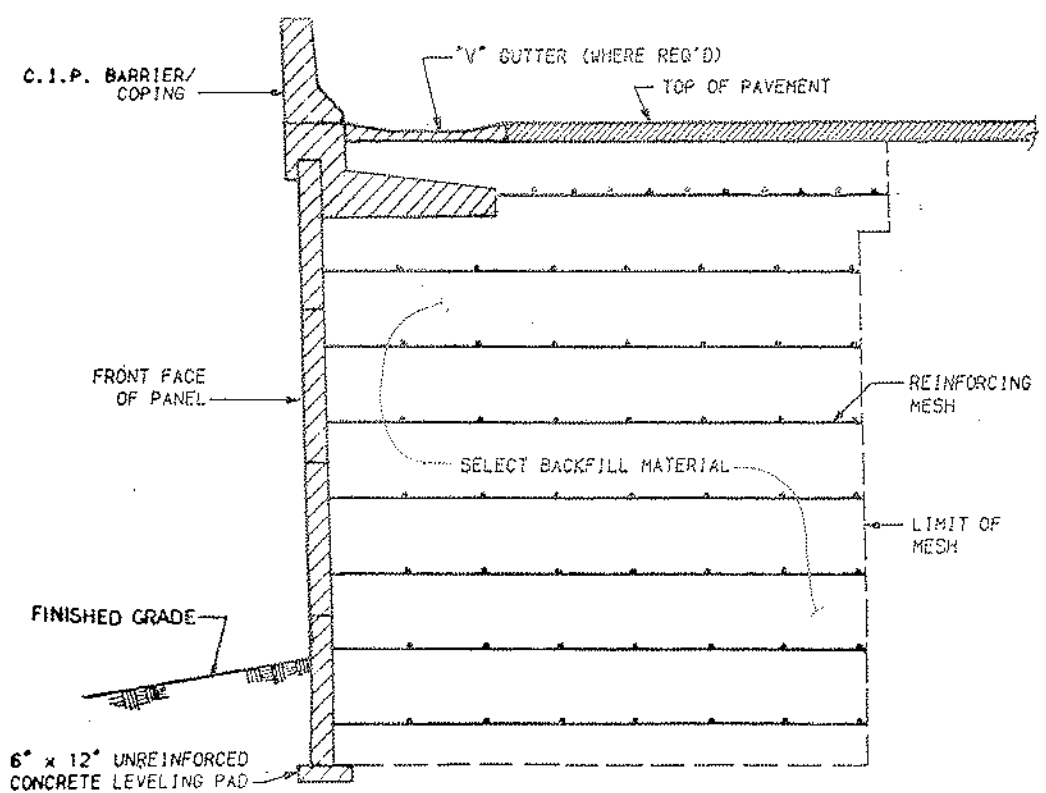
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LEVELING PAD DETAIL
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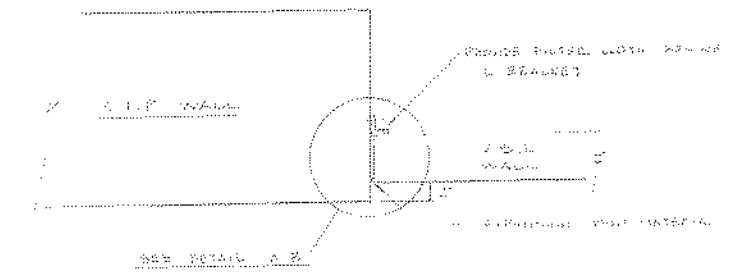


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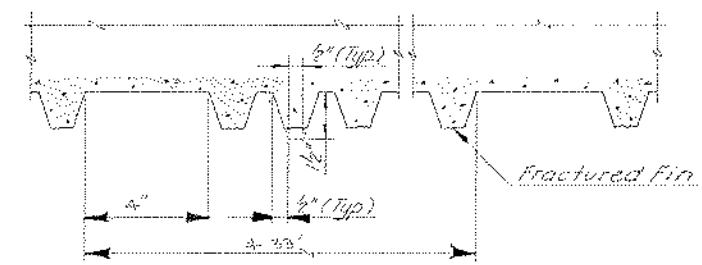


TYPICAL SECTION
N.T.S.

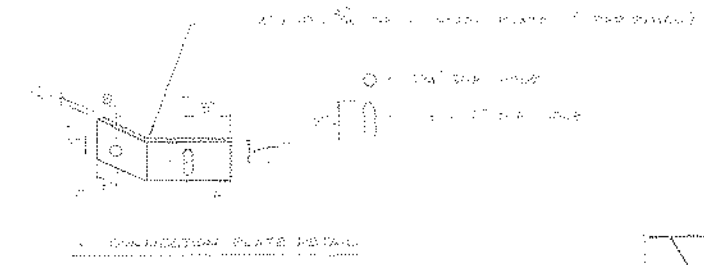
NOTE
FOR SITUATIONS WHERE DRAIN TRAP
NEEDED WITH THE BARRIER WALL, THE
DRAIN TRAP SHALL BE LOCATED WITHIN THE
WALL.



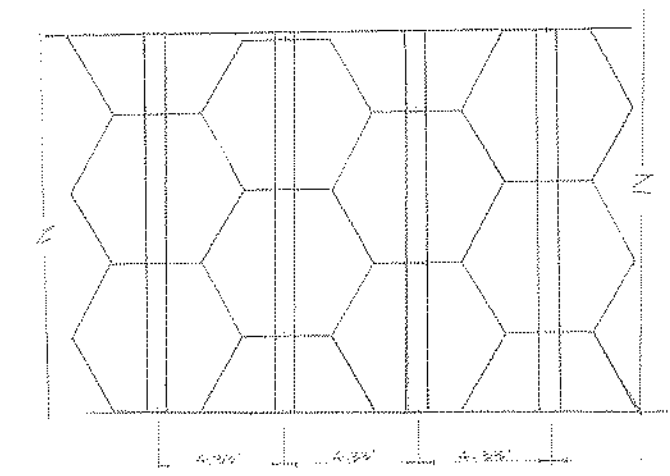
C.I.P. WALL/RETAINING WALL CONNECTION DETAIL
N.T.S.



TYPICAL ARCHITECTURAL DETAIL
No Scale



DETAIL 1-10
N.T.S.



TYPICAL ELEVATION SHOWING FRACTURED FIN
N.T.S.

REVISED	F.H.W.A. REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.			000-000-000-0-0-0	278-12

DES. DRN. CHK.

VSL Corporation

TYPICAL SECTIONS AND DETAILS

RT. 1 ARLINGTON, VA.

PRINT STATUS:

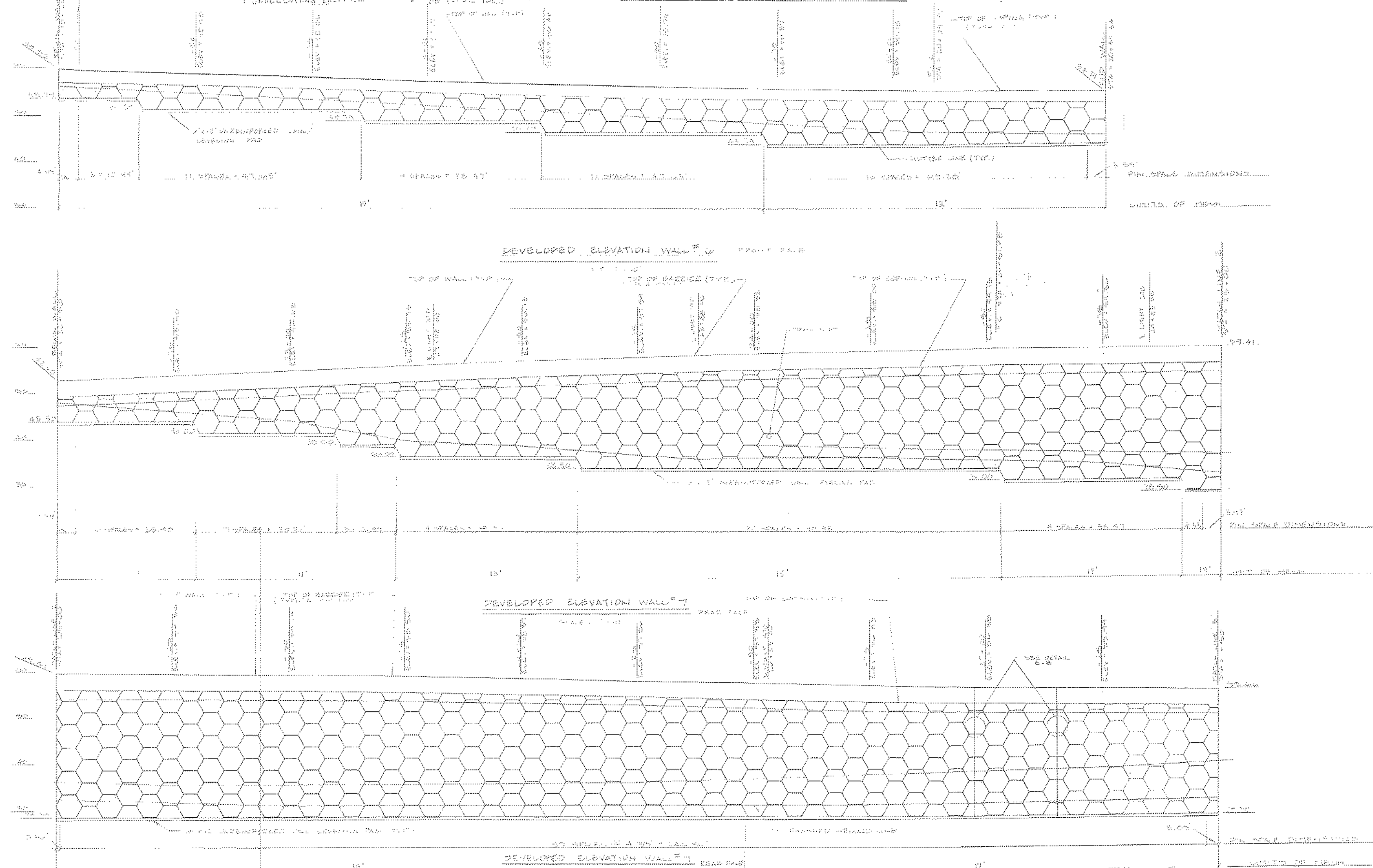
JOB NO:

SHEET: 3 OF 16

ESTIMATE OF QUANTITIES:		WALL #1
TOTAL CONCRETE WALL PANELS	=	11.12 (LINEAR FEET)
CONCRETE LEVELING PAD	=	11.12 (LINEAR FEET)
CAST-IN-PLACE COPING TYPE (A)	=	11.12 (LINEAR FEET)
TRAFFIC BARRIER/COPING TYPE (B)	=	11.12 (LINEAR FEET)

ESTIMATE OF QUANTITIES:		WALL #2
TOTAL CONCRETE WALL PANELS	=	11.12 (LINEAR FEET)
CONCRETE LEVELING PAD	=	11.12 (LINEAR FEET)
CAST-IN-PLACE COPING TYPE (A)	=	11.12 (LINEAR FEET)
TRAFFIC BARRIER/COPING TYPE (B)	=	11.12 (LINEAR FEET)

REVISED	F.H.W.A. NUMBER	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.			1001-000-100-100-01	1001-000-100-100-01



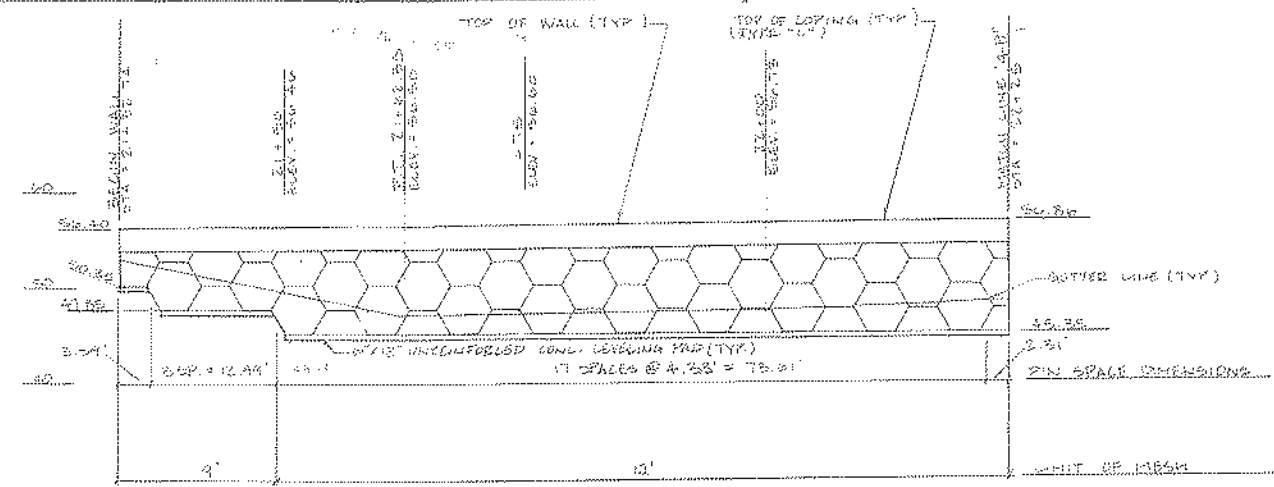
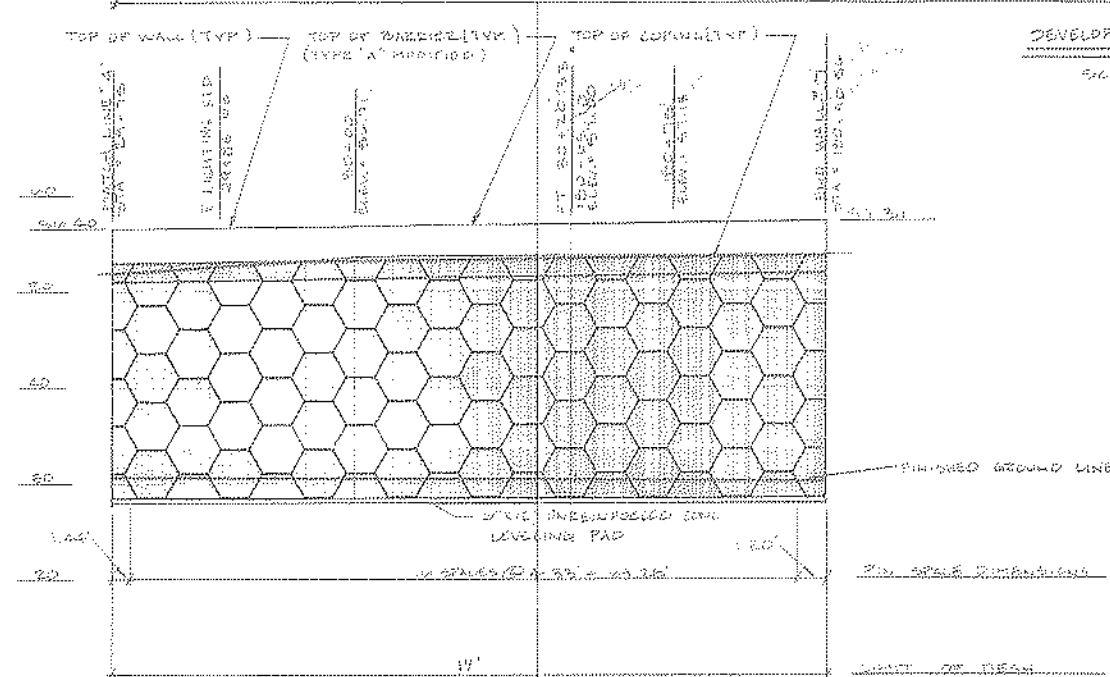
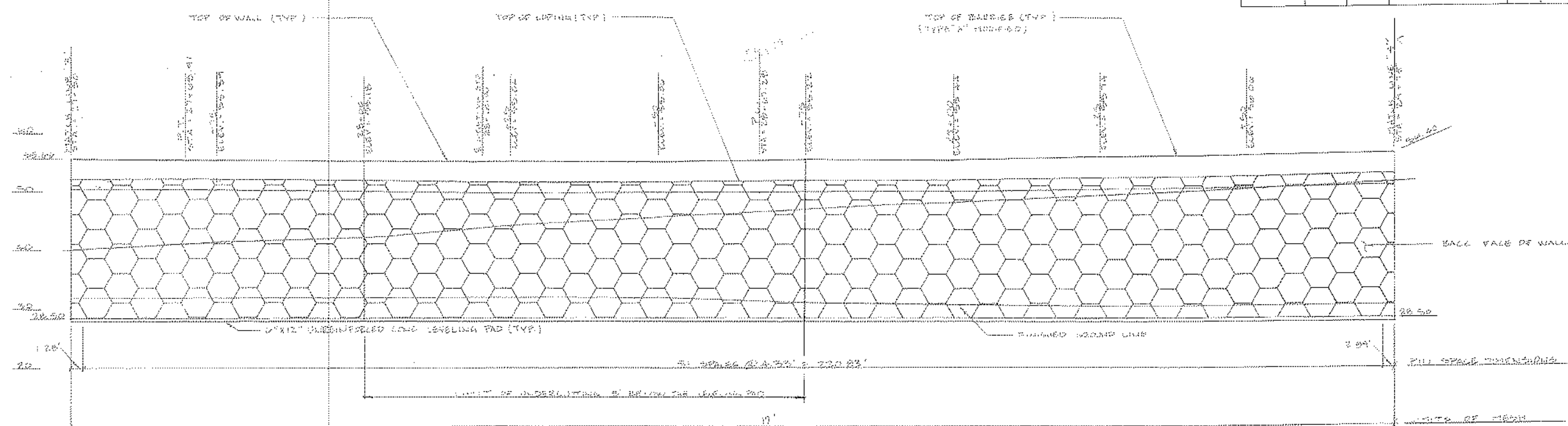
VSL Corporation
 1000 West 10th Street
 Fort Worth, Texas 76102
 Phone: 817/735-1000
 Fax: 817/735-1001

RETAINED EARTH WALL
 RT. 1 ARLINGTON, VA.

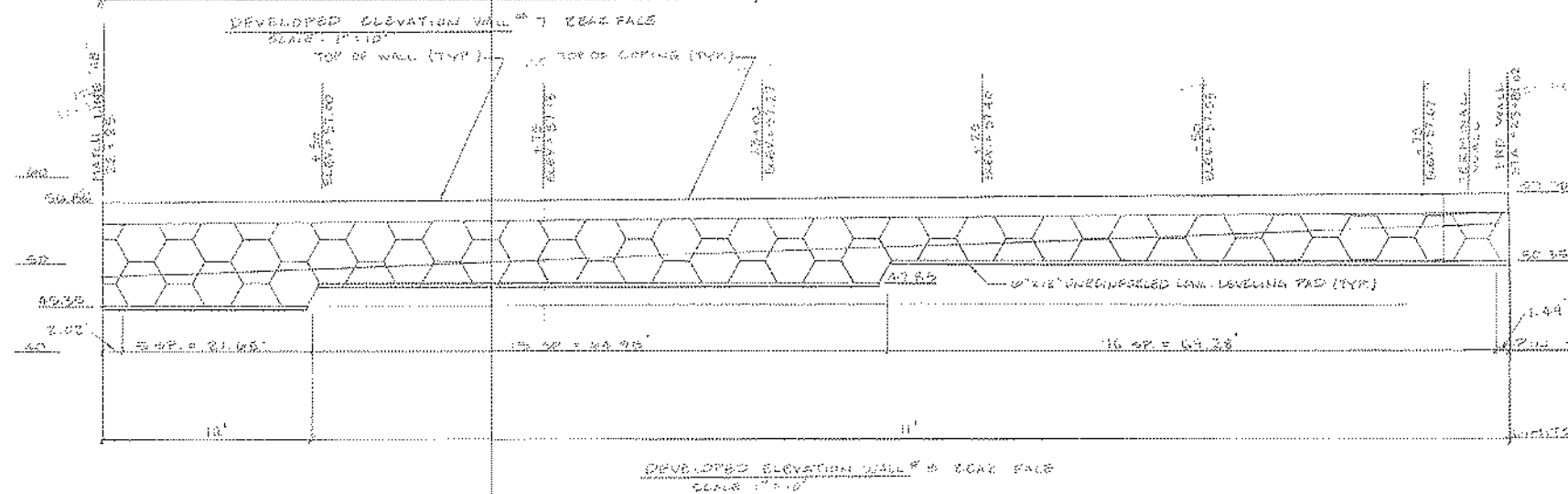
PRINT STATUS:

JOB NO. VA-1001-000-100-100-01

SHEET: 1 OF 1



ESTIMATE OF QUANTITIES:		WALL #1
TOTAL EXCAVATION	= 12	(CUBIC YDS.)
CONCRETE WALL PANELS	= 1967	(SQUARE FEET)
CONCRETE LEVELING PAD	= 252	(LINEAR FEET)
CAST-IN-PLACE COPING TYPE (A)	= 253	(LINEAR FEET)
TRAFFIC BARRIER/COPING TYPE (B)	=	(LINEAR FEET)
30 VOA SELECT FILL	= 849	



RETAINED EARTH WALL

RT. 1 ARLINGTON, VA.

PRINT STATUS:

JOB NO:

VAD01-5

SHEET:

4

OF: 11

DES.

DES.

DRN.

DRN.

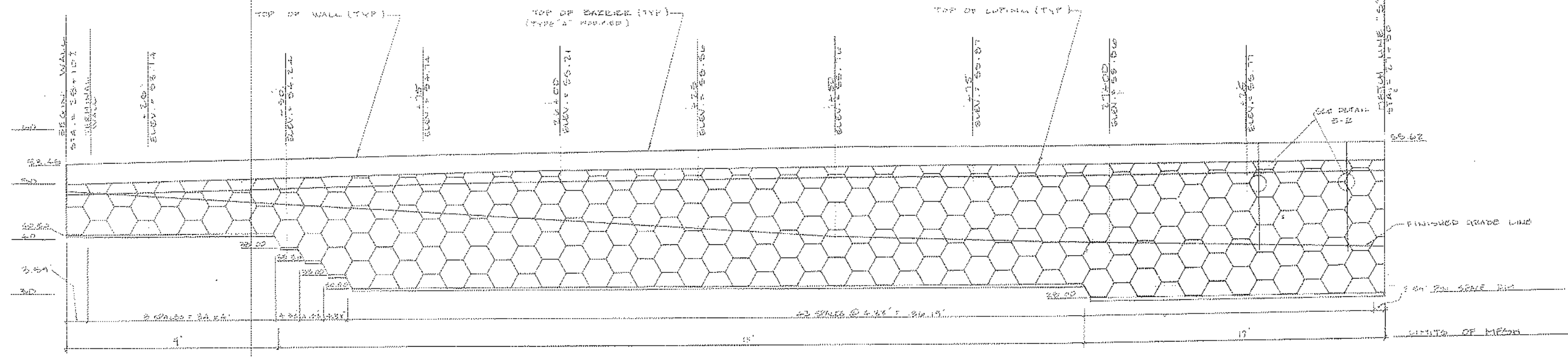
CHK.

CHK.

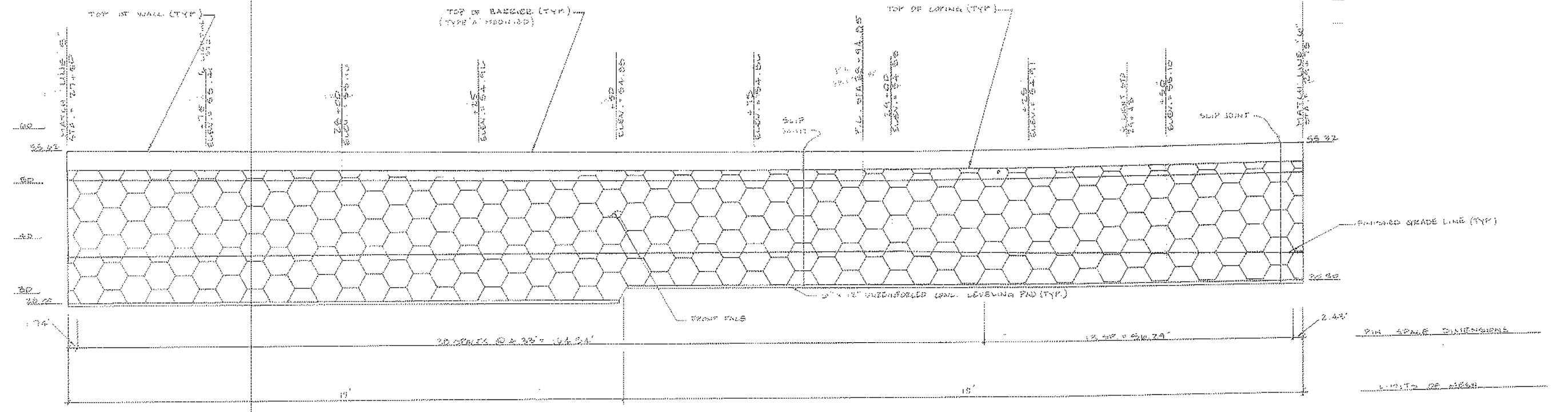
VSL Corporation

RT. 1 ARLINGTON, VA.

REVISION	F.H.W.A. REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.			0001-000-102.0-501	22B- (5)



DEVELOPED ELEVATION WALL #9 FRONT FACE
SCALE: 1" = 10'



DEVELOPED ELEVATION WALL #9 FRONT FACE
SCALE: 1" = 10'

VSL Corporation

10000 Lee Road, Suite 100
Arlington, Virginia 22206
(703) 241-1000

RETAINED EARTH WALL

RT. 1 ARLINGTON, VA.

DES. 3.0

DRN. 3.0

CHK. 3.0

1.05

1.05

1.05

PRINT STATUS:

JOB NO: 0001-000-102.0-501

SHEET: 5 OF 1

